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PSYCHOLOGICAL APPROACHES TO THE BIOGRAPHY OF GENIUS[1]

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PROBABLY few words have acquired a greater variety of connotations than *genius*. On this occasion I shall disregard the numerous meanings attached to the word in the first two thousand years of its history and call attention only to common usages in modern English.

In a popular sense genius is often used to designate some kind of mystical gift that can not be explained by the ordinary laws of human nature. The scientist, of course, rejects this usage. Havelock Ellis and others have used the term as practically synonymous with eminence. Galton, while employing the criterion of eminence, follows Samuel Johnson in defining a genius as one who is endowed with superior intellectual ability. This definition is essentially identical with that given in Warren's "Dictionary of Psychological Terms," 1934, and is the one I prefer.

The *sine qua non* of genius is the ability to acquire and to manipulate concepts, the shorthand symbols without which abstract thinking can not proceed. However, there are many levels of aptitude for concept mastery and the question arises where genius may be said to begin. We have at one extreme Dr. Fields' laboratory rats which required thousands of trials and a good part of their lives to learn to respond to triangularity in visual stimuli; that is, to acquire one crude concept. At the other extreme are the Newtons

[1] Presidential address before the Pacific Division of the American Association for the Advancement of Science, Seattle, June 18, 1940.

and the Aristotles. The intermediate levels range upward through infra-human intelligence, average human intelligence and the superior grades that permit higher and higher levels of abstraction. Any line that may be drawn to demarcate genius is purely arbitrary. Whether one restricts the term to the ablest in many millions, in a few thousand or in a few hundred, does not matter provided the facts are stated.

Another problem is that of identifying the individuals who qualify at a particular level of genius chosen for investigation. I have referred to the criterion of eminence. Unfortunately, eminence as measured by popular acclaim or even by space in biographical dictionaries is influenced by other circumstances than intellectual achievement. The population it affords is the result of innumerable selective factors which vary from age to age and from culture to culture. The genius who survives as such has successfully run the gantlet of premature death, the inanities of formal education, the social and ethical pressures of his immediate environment and the more general cultural influences that have given direction and content to the civilization in which he was born. To study only the biographies of historic characters gives us a one-sided picture in that it tells us nothing about the potential geniuses who failed to achieve greatly. To complete the picture it is necessary not only to investigate the life histories of eminent persons but also to inaugurate researches that will proceed in the opposite direction. That is, we should identify early in life those individuals who are intellectually gifted, secure quantitative measures of their mental and physical traits, then follow their careers through life.

For twenty years parallel studies in these two directions have been in progress at Stanford University. On the one hand, the mental development of 300 eminent individuals has been traced backward to childhood; on the other hand, the development of more than thirteen hundred intellectually superior subjects has been followed in the forward direction from childhood to early maturity. It is possible to give you this evening only a few highlights from these two lines of investigation.

I

I shall first review some of the more recent approaches to the biographical study of eminent persons. As you well know, the highly original publications of Francis Galton between 1869 ("Hereditary Genius") and 1889 ("Natural Inheritance") stimulated many interesting investigations of the origin and qualities of great men. Unfortunately, the methodology of these studies soon became stereotyped along statistical lines, with failure to take advantage of progress in individual psychology. It has long seemed to me that the writing of a biography is as much a psychological as a historical undertaking and that biographers fail as often from lack of psychological insight as from any other cause. Not infrequently an otherwise competent biographer overlooks crucial facts in his subject's mental life or else interprets them in ways that are psychologically unsound. It was a striking example of such erroneous interpretation that led me to apply to the Commonwealth Fund for a grant to finance a research on the early mental development of historical geniuses. At that time my study of California gifted children was under way and the possibility of cross illumination from the two lines of approach seemed promising.

The erroneous interpretation referred to was found in Karl Pearson's "Life, Letters and Labors of Galton." In a discussion of Galton's intellectual precocity Pearson had presented an extraordinary array of documentary evidence regarding his subject's early accomplishments. Francis learned to read at the age of two and a half years and wrote a letter before he was four that has been preserved. By the age of five he could read "most any English book" and some French, could cast up any sum in addition, had mastered all the multiplication table except the 9's and 11's, knew the table of English money and could tell time by the clock. Now it happens that all of these and several other dated performances of Galton have been standardized by psychologists on unselected children of different ages, and that the mental age necessary for each performance is known. By the use of such norms it is possible in the case of Galton to estimate with considerable assurance the lowest IQ that would account for the facts. This was unquestionably in the neighborhood of 200, a figure not equalled by more than one child in 50,000 of the generality.[2] Yet Pearson was so unaware of the significance of the performances he had described as to assert: "I do not think we can say more than that Francis Galton was a normal child with rather more than average ability."

The research for which funds had been provided was carried out by Catharine Cox and two assistants. The first task was to select a group of eminent subjects in such a way as to avoid the bias that is sure to enter when selection is subjective and haphazard. Cox began with Cattell's list of the 1000 most eminent individuals of history as determined by the space devoted to them in biographical dictionaries. Taking the 500 most eminent of Cattell's list, she eliminated from this group those born before 1450, those who belonged to the hereditary aristocracy or nobility, and

[2] Lewis M. Terman, *Am. Jour. Psychol.*, 209–215, 1917.

a few others, arbitrarily, whose eminence had little or no basis in intellectual achievement. This left her with 300 subjects.

Cox and her assistants combed the biographies of these subjects for data on early mental development as indicated by interests, education, school standing and school progress, friends and associates, reading, production and achievement. Special attention was given to evidence from documentary sources. The material thus assembled ran to 6,000 typed pages. The evidence for each subject was then examined independently by three psychologists who were intimately acquainted with age norms of mental performance. Their task involved two things: (1) estimation of the minimum IQ that would account for a subject's childhood performances, and (2) a rating of the reliability of the evidence on which the IQ estimate was based. The averages of the three estimates for all individual subjects were the primary data for this part of the study.

It must be emphasized that the IQ as reckoned is an estimate of the lowest IQ that could reasonably account for the recorded facts; the actual childhood IQ's of historical geniuses are of course indeterminate.

For the entire group the estimated minimum IQ's ranged from 100 to 200, with an average of 155. The average is more than three standard deviations above the mean of the generality. Low estimates in the range of 100 to 120 IQ occurred only when there was little biographical information about the early years. The mean was highest for philosophers (170), and next highest for poets, novelists, dramatists and revolutionary statesmen (160). The lowest was for soldiers (125), the next lowest for artists (140) and musicians (145). The mean for scientists (155) was identical with the mean for the total group.

It will be understood, I trust, that IQ estimates of this kind are not to be taken too literally. For a majority of the subjects the information on which the estimates were based was far short of what could be desired. However, despite all inadequacies of the data I believe that the author's main conclusion is warranted: namely, that the genius who achieves highest eminence is one whom intelligence tests would have identified as gifted in childhood. The author warns us that the converse of this does not follow; we may not conclude that every child who tests high will become eminent. Her data suggest that those who do achieve greatly are characterized not only by superior intellectual ability but also "by persistence of motive and effort, confidence in their abilities and great strength or force of character."

That personality traits are influential in determining both the level and the direction of achievement can not be doubted. We shall see later that this is certainly true of the gifted children I have studied. However, one must also take account of the part played by chance. For a given type of achievement to be possible one must be born not too far from a given time and place. It is an interesting game to try to imagine how differently any list of eminent persons might read if every one now in it had lived a generation or two earlier or later. The soldiers would nearly all bear strange names, perhaps a majority of the statesmen, especially revolutionary statesmen, and doubtless many of the writers and scientists.

Apart from time and place of birth, there are other chance factors in vast number that are capable of shaping the life of a gifted youth. Newton at 15 had left school and was tending his mother's farm; but for the timely visit of an uncle who had attended Cambridge it is unlikely that he would ever have received the education that made possible his great discoveries. Victor Cousin was bred in the gutter and was illiterate at the age of ten when he happened to befriend a bully's victim in a street fight, with the result that the latter's mother sought him out and gave him an education. Faraday left school at 13 and at 14 was apprenticed to a bookbinder. It was the reading of an article on electricity in an encyclopedia given him to bind that first stimulated his interest in science. Even this would probably have got him nowhere had not Humphrey Davy been near to lend a helping hand.

In a study like that of Cox, special interest attaches to certain eminent persons who have been cited as examples of childhood backwardness. In every one of these cases the facts clearly contradict the legend. Goldsmith was characterized by Samuel Johnson as "a plant that flowered late," and a childhood teacher said of him in her old age, "never was so dull a boy." Actually Goldsmith was writing clever verse at the age of 7 years and at 8 was reading Ovid and Horace. His IQ was probably 140 or higher. Sir Walter Scott is said to have been a dunce when he attended the Musselburgh school. The facts are that he never attended this school, that when only 7 years old he read widely in poetry and in his prose at this age used correctly such words as "melancholy" and "exotic," that by age 10 he had collected a small library of ballads and that at 13 he lay awake nights reading Shakespeare when he was supposed to be asleep. His IQ was at least 150.

Other alleged dullards represent a type often encountered in the old-fashioned Latin school, *i.e.*, the youth who hated Latin and Greek but had a natural talent for science. Liebig, the founder of physiological chemistry, was the despair of his language teachers. At 15 he left school and was apprenticed to an apothecary because he wanted to be a chemist. At 17 he managed to enter a university and at 20 was awarded

the Ph.D. degree. John Hunter, British surgeon and anatomist, left Latin school at 13 and spent four apparently idle years roaming the woods and fields, "watching the ants, the bees, the birds, the tadpoles, and caddis-worms, pestering people with questions about which nobody knew or cared anything." Alexander von Humboldt and his brother Wilhelm, two years older, were privately tutored along the usual classical lines. Wilhelm liked languages and was early recognized as gifted; Alexander, caring only for nature, was considered mentally slow. Both became eminent, but Alexander outstripped his brother.

In the cases just cited one notes a tendency for the direction of later achievement to be foreshadowed by the interests and preoccupations of childhood. I have tried to determine how frequently this was true of the 100 subjects in Cox's group whose childhood is best documented. Very marked foreshadowing was noted in the case of more than half of the group, none at all in less than a fourth. Macaulay, for example, began his career as historian at the age of 6 with what he called a "Compendium of Universal History," filling a quire of paper before he lost interest in the project. Goethe's literary juvenilia are perhaps the most remarkable that have ever been preserved. Ben Franklin before the age of 17 had displayed nearly all the traits that characterized him in middle life; manual skill, scientific curiosity, religious heterodoxy, wit and buffoonery, political and business shrewdness and ability to write. At the age of 70, when on a diplomatic mission in England, he dug up an article which he had written in his teens, published it practically without change, and created a political sensation. At 11 Pascal wrote a paper on sound and was so interested in mathematics that his father thought best to deprive him of books on this subject until he had first mastered Latin and Greek. Pascal secretly proceeded to construct a geometry of his own and covered the ground as far as the 32nd proposition of Euclid. At 14 Leibnitz was writing on logic and philosophy and composing what he called "An Alphabet of Human Thought." He relates that at this age he took a walk one afternoon to consider whether he should hold the doctrine of substantial forms.

In working with data of this kind the investigator must of course be wary, for even under the pen of a conscientious biographer the childhood period is likely to be colored by the halo of adult achievement. The evidence, however, is indisputable in the case of nearly all the musicians, and hardly less convincing in the case of mathematicians and artists. There are few great poets who did not show unusual poetic talent before the age of 15.

We can go further and say that the literary style of a poet's juvenilia usually resembles that of his mature productions. Let me illustrate by a single example. I shall read to you a few lines from two poems, both of romantic content and both written at the age of 14. I am sure you will have no difficulty in guessing which was written by Alfred Tennyson and which by Samuel Johnson.

THE BRIDAL

The lamps were bright and gay
On the merry bridal-day,
When the merry bridegroom
Bore the bride away!
And the chapel's vaulted gloom
Was misted with perfume.
"Now, tell me, mother, pray
Why the bride is white as clay,
Although the merry bridegroom
Bears the bride away."

TO A YOUNG LADY ON HER BIRTHDAY

This tributary verse receive, my fair,
Warm with an ardent lover's fondest prayer.
May this returning day forever find
Thy form more lovely, more adorn'd thy mind;
All pains, all cares, may favouring Heaven remove,
All but the sweet solicitudes of love!
May powerful nature join with grateful art,
To point each glance, and force it to the heart!
O then, when conquer'd crowds confess thy sway,
When ev'n proud wealth and prouder wit obey,
My fair, be mindful of the mighty trust:
Alas! 'tis hard for beauty to be just. . . .

In the first you recognize the light rhythm, alliteration, and pretty jingles so characteristic of Tennyson, and in the second the ponderous periods of Sam Johnson and his predilection for big words. What could be more Johnsonese than the line "all but the sweet solicitudes of love"? Or than the adage with which the verse ends: "Alas! 'tis hard for beauty to be just"? Johnson's writings and his conversation throughout his life were peppered with adages borrowed or improvised.

The early interests and displays of special talent by Cox's subjects were often disregarded in the vocational guidance given them by parents and teachers. In no less than 20 of the 100 cases whose childhood is best known there was pressure to turn the subject into another field than that in which eminence was achieved. The destiny that half of these had to escape was the legal profession. Balzac's parents tried for five years to starve him into submission that they might make a lawyer of him. Dumas (*père*) was first destined for a military career, later for the priesthood and was finally apprenticed to a notary. When Victor Hugo was 19 his father offered him an allowance if he would relinquish literature for a more substantial profession. Victor preferred to live in a garret and write. Coleridge's father wanted his son to be a parson, but

fortunately the father died and the boy was reared by an uncle who recognized literary genius when he saw it.

The guidance of gifted children is made more difficult by their versatility. Intellect by its very nature is highly general, and it follows that to one who is intellectually superior many fields of achievement are possible if the requisite interests and drives are present. The versatility of a few geniuses has received considerable attention, but the less spectacular cases are overlooked. People like to believe that the genius as a rule is no better than the rest of us except in one particular. The facts are very different. Except in music and the arts, which draw heavily on specialized abilities, there are few persons who have achieved great eminence in one field without displaying more than average ability in one or more other fields.

A few years ago, one of my students, Ralph K. White, made a study of the versatility of Cox's 300 geniuses.[3] Using the biographical information assembled by Cox, White and another psychologist rated each subject on the ability shown in 23 different fields. The results indicated that a majority of the subjects displayed more than ordinary ability in 5 to 10 fields. The mean versatility index was highest for non-fictional writers, statesmen and philosophers (around 7.5); somewhat lower for scholars, religious leaders, scientists, poets, mathematicians, novelists and dramatists (around 6.7); much lower for soldiers and artists (4.3 and 4.0), and lowest of all for musicians (only 2.7).

White further analyzed his ratings to see what abilities tended to appear together. It was found, for example, that science, mathematics, invention and handwork form a rather closely-knit group; poetry, novels and drama another. Philosophy, social theory, history and languages form a third but less compact structure. Religious leadership is allied with politics and administration, while musicians stand pretty much alone. One of the most interesting relationships is that between art and the science cluster. Leonardo da Vinci is here the supreme example.

Another approach to the biography of genius is by way of psychoanalysis, which investigates the motivational dynamics that shape the individual personality. The contributions from this direction now make up a vast literature difficult to appraise. To any but the most orthodox Freudian much of it will appear highly extravagant and far fetched. Some of the contributions, however, appeal to the psychologist as in line with common observation. One does not have to accept the elaborate superstructure of symbolism erected by Freud to be convinced that psychoanalysis has profoundly influenced modern theories of personality. There are few psychologists who longer doubt that the crucial influences shaping the lives of some persons stem from their childhood experiences: for example, from parent-child conflicts or attachments, from sibling relationships, from the sense of not being wanted or from frustration in its myriad forms. It is impossible to understand the unsexed personality of John Ruskin without knowledge of his parental attachments, the rebellious spirit of Lord Byron without knowledge of his deformity and of his maternal conflicts, or the messiah complex of John Wesley without knowledge of the mother-inspired ideal to which he was molded by family pressures. The phenomenon called Hitler surely is not to be explained in terms of extraordinary intellectual endowment, but rather in terms of personal frustrations, displaced hatreds and fanatical aggressions.

I believe there is factual basis for Lasswell's suggestion that the role of rebel or agitator is sometimes only a continuation of the child's fight against parental tyranny. Emma Goldman, with psychological insight unusual in autobiographies, calls attention to the possible relationship between her career as anarchist and the brutalities she suffered from her father in childhood; she did not think it accidental that one of her foremost associates among the anarchists had a similar background of domestic tyranny.

Lange-Eichbaum, a German psychiatrist, has emphasized the importance of inner conflicts and tensions of whatever kind as stimulants to great achievement. he believes that without such irritants no one ever puts forth his maximum effort; that the personality happily adjusted to its environment and never stirred to action by opposition or frustration is foredoomed to obscurity. Examining from a psychiatric point of view the lives of a large group of historical geniuses this author concludes that the more eminent the subject the more marked the evidence of inner conflict bordering on the psychopathic. One would like to see this conclusion checked by a research commission composed of historians, psychiatrists and psychologists working with an objectively selected population.

In evaluation of these various approaches to the study of historical geniuses I wish to go on record as believing that all of them have merit enough to justify their further cultivation. At the same time, any one who has attempted to draw conclusions from the fragmentary information that can be gleaned from biograpical works is painfully aware of the limitations of his material. One's interpretations are at best only tentative and suggestive, lacking always the finality of positive proof. It is a relief, accordingly, to turn to the investigation of living subjects who may be studied firsthand at successive age levels with unlimited opportunity for correlating factual data in the individual's life history.

[3] Ralph K. White, *Jour. Social Psychol.*, 460–489, 1931.

II

By the study and follow-up of intellectually superior children we can find out what such individuals are really like in early life and what kind of men and women they become. Data which I had been able to secure from tests and observations of about 100 gifted children between 1910 and 1920 suggested that many of the traditional beliefs on these points contained a preponderant element of superstition. It was obvious, however, that to secure anything like conclusive evidence would require an expensive study of a large and representative group of subjects.

By good fortune a grant was obtained from the Commonwealth Fund for an investigation of the desired scope. In 1922 a school population of more than a quarter of a million was sifted by methods which brought to light practically all the children capable of earning an IQ of 140 or higher, a score that is attained by only five or six children in a thousand. More than 1000 subjects of this degree of intellectual superiority were located in the elementary grades and about 300 in high schools, a population large enough to yield reliable statistical constants and sufficiently free from sampling bias to provide a sound basis for generalization. What is true of this group should be true of any similarly selected group in any comparable culture.

Let it again be noted that the gifted child is here arbitrarily defined as one whose score in tested intelligence is equalled by about one child in two hundred of the school population. Obviously the term *genius* can be applied to subjects of this grade of mental superiority only in a very liberal sense. The population studied by Galton was twenty times as highly selected, since it included only the most eminent in 4000 of the generality. The American "Who's Who" population is ten or twelve times as highly selected as my gifted group, and Cattell's galaxy of 1000 starred scientists is several hundred times as aristocratic. It is necessary to hold these comparative figures in mind in order to appraise justly the life achievements of the subjects I have studied.

The data secured for this group in 1922 include for a majority of the subjects two intelligence scores; twelve scores from a four-hour test of school achievement; scores from three tests of character, personality and interests; 34 anthropometric measurements; the results of a one-hour medical examination; ratings by parents and teachers on 25 personality traits; and a large amount of case-history information supplied by parents, teachers and field assistants. What is the gifted child like when we find him?

The medical examination and anthropometric measurements showed the typical gifted child physically superior to the average. The tests of personality and character yielded scores far superior to those of average children of corresponding age. In school achievement the gifted subjects scored almost as high as in IQ. A majority of them had in fact acquired a good mastery of the curriculum as far as two, three or even four school grades beyond that in which they were enrolled.

Marked unevenness in achievement was rare. Whereas the mean intelligence quotient of the group was about 150, the mean achievement quotients in reading, arithmetic, language usage, spelling, science information, literary information, historical information, and aesthetic information, were all in the narrow range between 137 and 152. The relative uniformity of these average scores establishes beyond question that a high degree of versatility is the rule in a group of this kind.

This is where our biographical study of gifted children began in 1922. It has now been under way long enough to give some indication of the probable life achievement of such a group. The thousand who were below high school age in 1922 now range from 22 to 32 years, with a median of about 27. The 1922 high school subjects range from 29 to 37, with a median of 33. I am still in contact with more than 95 per cent. of the original group.

For several years after 1922 the subjects were followed by information blanks that were filled out and mailed to me annually by the parents and teachers. In 1928 a second grant from the Commonwealth Fund made it possible to have field assistants retest most of the subjects and obtain a large amount of additional information through interviews with parents, teachers and the subjects themselves. The next follow-up was conducted chiefly by mail in 1936–37, but a liberal grant from the Carnegie Corporation a year ago has made it possible to keep three research associates in the field since last September testing and interviewing the subjects. As not all of the new data have yet been statisticised, most of the figures I shall report will be in round numbers subject to later corrections that will not materially affect the picture.

First a few vital statistics. The mortality rate of the group to date is below that of the generality of corresponding age. The same is true of the insanity rate. The incidence of suicide approaches more closely that of the generality.

At the present time nearly two thirds of the members of the group are or have been married, the proportion being about the same for men and women. The divorce rate is below that of the generality in California of corresponding age. Among those who have married, 40 per cent. of the men and 50 per cent. of the women married college graduates. The mean intelligence score of the subjects themselves is well

above that of their spouses, but the latter also test high.

The group has thus far produced about 500 offspring. Tests given recently to 300 of these who are above the age of two years have yielded a mean IQ of approximately 127, which represents about the expected regression toward the mean of the generality.

Has the intellectual superiority shown by this group in 1922 been maintained? In terms of intelligence test scores the answer is emphatically yes. The retests given both in 1928 and during the past year showed a majority of the subjects close to the 99th percentile of the generality. This is true even of those whose careers have not been particularly successful. Although there are exceptions to the rule, the intellectually gifted individual can be identified almost as accurately in the third elementary grade as at age 30.

With regard to educational achievement, the average member of the group enters high school at 13 and college at 17. Nearly 90 per cent. enter college and of those entering about 93 per cent. graduate. Although averaging nearly two years younger than their classmates, they engage more extensively in extra-curricular activities, receive more student-body honors and are several times as likely to graduate with distinction.

Approximately two thirds of the men who graduate, and half of the women, go on for graduate work. Of some 300 men who have completed their graduate studies, about 50 have received a Ph.D. degree, about the same number a medical degree, about 85 a law degree, and about 35 a degree in engineering or architecture. Less than one tenth as many women as men have obtained a graduate degree beyond the M.A. For the sexes combined the incidence of higher professional degrees is perhaps twenty or thirty times as great as for the general population.

In appraising the life achievements of these subjects it is necessary to take account of the severe economic depression that has spanned most or all of their adult years. This circumstance has made harder the way of many and has diverted some permanently from their educational goals.

The averaged earned income of the men at age 30 is around $3,000 a year. About a dozen of the men are earning between $10,000 and $15,000 a year. In general, the women who are gainfully employed earn only about half as much as the men, and the maximum reached by women is only about one fifth the maximum for men. Income, however, is a poor measure of achievement, particularly in the case of young men just starting on their professional careers. Some of the most promising members of the group are at present earning less than $2500 a year.

Turning to other indications of achievement we find that about 50 of the men and a dozen of the women are teaching in colleges or universities. Seven of these are already executive heads of departments.

Publications by the total group number hundreds of articles in professional or technical journals, at least 20 books, and a vast number of short stories, popular articles and poems. The books include text-books, scholarly treatises, a semi-popular book on invention, five volumes of fiction and two books of poems. Eighty or more patents have been issued to men of the group, none to any of the women.

As a relief from impersonal statistics I will cite briefly a few examples of individual accomplishment. The list could be multiplied many times in length.

1. A professor in one of the physical sciences and head of his department in a great university. Has published three text-books, more than 50 research articles, and has taken out more than a score of patents. Well known nationally and internationally.

2. A professor of physiology in a state university and head of his department. Has devised new techniques for heart diagnosis which he has been called upon to demonstrate in leading medical schools of this and other countries. At the age of 36 has 52 publications to his credit.

3. A brilliant student who took his master's degree at 20 in classical literature, then turned to business and at 27 became chief investment analyst for a forty million dollar educational foundation.

4. A musical composer of international reputation, nurtured in poverty and totally unschooled until the age of 17. He is the author of three books and dozens of articles on musical theory. In the last three years alone he has composed 60 major orchestral works, written a book on melody and learned two foreign languages.

5. An aeronautical engineer who at 32 is coordinator of research in a ten million dollar aeronautical laboratory.

6. An artist in the middle twenties who is an important member of Walt Disney's staff with a salary of $1000 a month.

7. A woman who has shown exceptional talent in several fields. Between the ages of 7 and 15 she wrote a vast quantity of poetry, some of which was rated by professors of English as equal to the best juvenilia of eminent English poets. After graduating from college at 17 she wrote a novel, studied painting for a time, then turned to sculpture and was for three years the sole pupil of one of the best known sculptors in Europe. She bids fair to become eminent in this field.

8. A woman of 28 who has a Ph.D. degree of English and has published a volume of poetry that won high praise from critics. Like Number 7, she began writing poetry in early childhood and produced several juvenilia that compare favorably with those of eminent authors.

9. A woman who was awarded the degree of doctor of science by the Pasteur Institute at age 25 and is engaged in medical research.

10. A woman who received the A.B. degree in engineering at 19, a graduate degree in mining engineering at 21, and a doctorate in metallurgy at 24. She is assistant to the director of a research laboratory of a large steel firm.

We have seen in the case of historical geniuses that the direction of adult accomplishment is often foreshadowed during the early years. In order to find whether this is true of my gifted group the records of men in the various fields are being compared with respect to childhood hobbies, school marks, achievement test scores, amount and kinds of early reading, trait ratings by parents and teachers, early social adjustment and other variables. Although the analysis has not been completed, the data are showing more than chance agreement between some of these variables and the field of adult achievement. This is particularly true of those who have accomplished the most. Achievement in music, literature and art is almost always foreshadowed in some degree.

The range of success in my group is very wide for both sexes and at the present time extends downward to occupations as humble as those of policeman, carpenter, gardener, gas station operator, department store floor-walker, store clerk, house-to-house canvasser, small rancher, seaman, telephone operator, typist and filing clerk. The question arises what factors other than intelligence are important determiners of achievement in such a group.

One, obviously, is sex. Although the women equal or excel the men in school achievement from the first grade through college, after school days are over the great majority cease to compete with men in the world's work. If they do not marry at once they accept whatever kind of respectable employment is at hand. After marriage they fall into the domestic role and only in exceptional cases seek other outlet for their talents. The woman who is a potential poet, novelist, lawyer, physician or scientist usually gives up any professional ambition she may have had and devotes herself to home, husband and children. The exclusive devotion of women to domestic pursuits robs the arts and sciences of a large fraction of the genius that might otherwise be dedicated to them. My data strongly suggest that this loss must be debited to motivational causes and to limitations of opportunity rather than to lack of ability.

Since the achievement of women is so largely determined by extraneous circumstances and is in any case so difficult to estimate, my investigation of the causes of success and failure has been confined to the male group. Three psychologists, working independently, examined the records of 600 men and rated each subject on life success. The criterion of "success" was the extent to which a subject had made use of his superior intellectual ability. The judges were instructed to give very little weight to earned income.

On the basis of these ratings the men were tentatively classified into three groups, composing roughly the highest fourth, the middle 50 per cent. and the lowest fourth. The highest and lowest fourths, or the A and C groups as we have called them, were then compared with respect to test scores of 1922 and 1928, family records, home environment, case histories, health data, trait ratings and many other items of information, in the hope that by reading the records backwards, so to speak, some light might be thrown on the factors that influence achievement.

The educational and occupational records of these two groups present a vivid contrast. Of the A's, 98 per cent. entered college and 90 per cent. graduated; of the C's, 70 per cent. entered and only 50 per cent. graduated. Three fourths of the A's but only a fifth of the C's completed one or more years of graduate work. Among those graduating, nearly one half the A's but only 4 per cent. of the C's were elected to Phi Beta Kappa or Sigma Xi. Half of the A's but only 10 per cent. of the C's had received appointment to scholarships, fellowship or assistantships. In professional or semi-professional pursuits were 96 per cent. of the A's as compared with 28 per cent. of the C's. Although salary had been given little weight in the success ratings, the average earned income of the A's was two and a third times that of the C's.

Let us turn next to the childhood records and test scores of the two groups to see what facts or circumstances are associated with differences in life accomplishment. We note first that during the elementary school years the A's and C's were about equally successful. Their average grades were almost identical, and the average scores on a four-hour achievement test were only a trifle higher for the A group. In high school the groups began to draw apart as a result of lower grades in group C, but it was not until the college period that the slump of this group assumed alarming proportions. The slump can not be blamed upon extra-curricular activities, for these were almost twice as common among the A's as among the C's. Nor can it be attributed to intellectual deterioration, for on every mental test, from 1922 to 1940, the average score of the C's has been only a few points lower than that of the A's. In a population so highly selected for intelligence that each person in its rates within the top one per cent. of the generality, the differences in success must necessarily be due chiefly to non-intellectual factors.

For one thing, the family backgrounds of the two groups differed markedly. Nearly twice as many A parents as C parents had graduated from college, and a similar difference was found between the siblings of A's and C's. Fathers of the A's were far more often in the professional classes. The important point here is that the educational tradition was stronger in families of the A group. In line with this is the fact that the Jewish element is three times as large among the A's as among the C's. The Jewish child is under

heavy pressure to succeed, with the result that he accomplishes more per unit of intelligence than do children of any other racial stock.

Significant differences between the groups were found in the childhood data on emotional stability, social adjustments and various traits of personality. The case histories and trait ratings obtained from parents and teachers in 1922 reflect these differences clearly. All the 1922 trait ratings except those for health averaged lower for the C group. That is, fifteen or more years prior to the classification of these subjects on the basis of adult achievement, teachers and parents had been able to discern personality differences that would later characterize the two groups.

The A-C differences are further evidenced in the marital records. The incidence of marriage is higher in the A group and the age of marriage is lower. Moreover, the A's marry better than the C's; the A spouses score higher in intelligence tests and include nearly twice as large a proportion of college graduates. Especially significant is the contrast in marital adjustments, for the incidence of separation or divorce is only a third as high in the A group as in the C group. This difference extends even to the parents of the two groups, the incidence of separation or divorce being only half as great for A parents as for C parents.

The A-C differences in marital adjustments appear to be symptomatic of more basic differences in emotional stability and integration of personality. With the aid of funds from the National Research Council a special study is being made of marital adjustments in the entire gifted population. This has shown that the A group scores higher than the C group not only in present marital happiness, but also higher in a test designed to measure general happiness of temperament, or what might be called aptitude for happiness.

The facts just reported appear to be in direct opposition to the Lange-Eichbaum theory that great achievement is associated with emotional tensions which border on the abnormal. In my gifted group success is associated with emotional stability rather than instability, with absence rather than presence of disturbing conflicts, with happiness of temperament and with freedom from excessive frustration. This does not necessarily mean that the Lange-Eichbaum theory has been disproved. It is conceivable that the personality factors which make for ordinary achievement under ordinary conditions are different from those which make for eminence of a superlative order. The two approaches agree in the conclusion that beyond a certain high level of intellectual ability success is largely determined by non-intellectual factors and that the number of persons who are endowed with abilities equal to great achievement is immensely greater than the number who will attain eminence.

Looking forward to the future, I regard it as unlikely that more than a few score of my 1,300 subjects will attain to a national reputation or that more than a dozen or so will become really eminent. It would be surprising if even one of them a hundred years hence should be found among the thousand most eminent persons of history. In sheer intellectual ability, however, I am sure that my group overlaps Cattell's thousand most eminent persons of history. Although the group certainly contains no intellect at all comparable with that of a Newton or Shakespeare, I believe it contains many who are intellectual equals of Washington, the nineteenth most eminent in Cattell's list, and perhaps some who are not intellectually inferior to Napoleon, the most eminent man of all time.

These specific estimates are of course not amenable to objective proof. They are offered merely as illustrations of a larger truth that no one can doubt who has studied either a group of historical persons or a group of living gifted subjects: namely, that genius and eminence are far from perfectly correlated. Why they are so poorly correlated, what circumstances affect the fruition of human talent, are questions of such transcendent importance that they should be investigated by every method that promises the slightest reduction of our present ignorance. So little do we know about our available supply of potential genius; the environmental factors that favor or hinder its expression; the emotional compulsions that give it dynamic quality; or the personality distortions that make it dangerous! And viewing the present crisis in world affairs who can doubt that these things may decide the fate of a civilization?

THE TIME CAPSULE[1]

By DAVID S. YOUNGHOLM

VICE-PRESIDENT OF THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY

WE are gathered here together to-day to take part in a ceremony that, so far as I know, is unique in history. We are the people who will be the last of our time to see the 800-pound letter to the future, which was posted at this point two years ago and which will now be sealed and sent on its journey into the ages to come.

[1] Address on the occasion of the sealing-in of the Time Capsule of the Westinghouse Electric and Manufacturing Company on the grounds of the World's Fair, September 23, 1940.

In a few minutes we expect to complete the sealing-in ceremony, which will be the last act of our generation in preparing the Time Capsule as a message for historians of the future.

At the bottom of this "Immortal Well," which goes 50 feet into the earth beneath the walls of the Westinghouse Building at the New York World's Fair, the world's first Time Capsule is about to begin its long journey into the future—a journey which, it is hoped, will extend through 5,000 years of time.

The Time Capsule is something like the imaginary "time machine" described for us by H. G. Wells, except that the Time Capsule can not hasten forward through time—it can only wait. For this purpose we have fashioned it with care, and we believe it is amply protected to remain safely in the soil—not 5,000 years, but perhaps as long as 15,000—if need be.

The Time Capsule represents months of careful planning and the combined efforts of hundreds of persons. Archeologists, historians, engineers, librarians, scholars and many others were consulted at every step so that the project might be as nearly successful as all our present-day arts and sciences could make it.

Leaving a message from our time to so distant a future presented three distinct problems: First, how to build a vessel capable of preserving the record; second, the selection and preservation of the objects to be included; and third, how to leave word of its whereabouts for future historians.

The capsule, as finally constructed, consists of a one-inch outer shell of cupaloy (chosen because of its electrical qualities and resistance to corrosion). It was cast in sections; each section threaded and screwed into the next and sealed in with asphalt.

The contents of the torpedo-shaped capsule were packed securely in an inner envelope of Pyrex glass, which was then sealed, evacuated, filled with nitrogen and set into the shell in waterproof mastic. The inner crypt is about six and a half inches in diameter and seven feet long.

More than 40 articles of common use are included. Among them are a fountain pen and mechanical pencil, a watch, an electric lamp, a tobacco pouch with zipper, tobacco, pipe, cigarettes, cosmetics, a woman's hat, eyeglasses, toothbrush and powder, a miniature camera and film, a razor, a can opener, specimens of our money, and so on. There are samples of the major metals and alloys; textiles, including wool, cotton, silk, linen, rayon, glass fabrics, rubber fabrics, asbestos cloth; materials such as Portland cement, asbestos, synthetic and natural rubber, synthetic plastics; also samples of coal (which may be rare in 5,000 years), seeds of staple food crops and many other items.

Most important is a carefully prepared microfilm "essay" on our times, taken from books, almanacs, pictures, arranged in logical order to cover all the major activities of human life. Multi-lingual texts, a dictionary and an idiomatic lexicon will enable future historians readily to translate the texts of the microfilm. All film in the capsule is cellulose acetate especially prepared for permanence. The microfilm contains a total of more than 23,000 ordinary book pages, reproducing more than 10,000,000 words, and many hundreds of pictures. A microscope is enclosed to enable "futurians" to read the text. Complete directions in text and picture are given for the construction of a larger reading machine and a motion picture projection machine.

For use with the latter, a newsreel is enclosed, specially prepared for the people of A.D. 6939. This contains nearly a score of historic, typical or significant scenes of our day, with sound.

Word has been left for future archeologists in the form of a Book of Record, printed with specially compounded permanent inks, on 100 per cent. rag permanent book paper. Copies have been sent to libraries, museums and other repositories throughout the world. Some will surely survive, either in the original form or translated into new languages that arise. In this respect we have the example of the Egyptian papyrus, a paper-like material that has lasted, without special protection, for many hundreds of years.

In order that futurians may know when the year 6939 has come, the equivalent of this date is given in the book not only in our own calendar, but also in the Chinese, Jewish, Mohammedan and Shinto calendars. If none of these kinds of calendars survives, futurians may still calculate the years elapsed by reckoning from astronomical data supplied by the United States Naval Observatory. These include the number and dates of eclipses of the sun and moon in 1939, the positions of the planets and the angle of the earth's pole relative to the north star.

The U. S. Coast and Geodetic Survey has provided a description of the survey's network of stations across the United States, astronomical and geodetic locations of nearby permanent stations, and the exact latitude and longitude of the Time Capsule, determined by a special survey. Given to the third decimal point in seconds, these geodetic coordinates are sufficiently accurate to locate the spot with an error of less than an inch. They are: Latitude 40° 44′ 34″ .089 north of the Equator; Longitude 73° 50′ 43″ .842 west of Greenwich.

If other guides fail, the futurians can still find the capsule. Minute directions have been prepared for constructing and using electromagnetic instruments to locate it by the methods widely used to-day.

Finally, that our language may not be lost, the book contains a simple but ingenious key to English which will permit readers to translate our tongue and to pro-

nounce it, 1938 style, as well. This was prepared by Dr. John T. Harrington, of the Smithsonian Institution, and has caused much comment and interest among students of our language.

It is impossible, of course, to detail here all the studies and reasoning which led to the construction of the Time Capsule and selection of its contents. We have undertaken with humility the enormous task of leaving this message to the future, realizing well that no selection of ideas and materials, no matter how large, could really do justice to the astonishing variety and vigor of our age. Whether, in the end, the project can achieve its purpose depends on ourselves and our posterity. The engineering difficulties of removing the Time Capsule from its resting place can probably be counted upon to protect the capsule from vandalism. We feel that the good instincts of the human race may be relied upon to preserve word of its whereabouts for the generation to whom it is addressed.

We are often asked whether the Time Capsule will not be beneath the ocean when 5,000 years have elapsed. This question is raised because there is a general belief that the eastern coast of the United States is slowly sinking, and that as a result the ocean will rise higher and higher, finally covering these parts. The best answer to that comes from the U. S. Coast and Geodetic Survey, which has repeatedly surveyed bench marks along the Atlantic coast. They tell us that no evidence can be found that the coast is either rising or sinking. If it should be sinking, the rate of motion must be as slow as an inch a century, or else the sensitive instruments would long ago have detected it. At the rate of an inch a century, 5,000 years would see a sinking of only about four and a half feet. Since we are at this point 25 or more feet above sea level, we feel that the capsule will be safe from the ocean during its appointed time.

In addition to all the other protections that have been thrown around the Time Capsule, we are now about to place one more. The capsule rests at the bottom of a well which was made by driving a twelve-inch pipe into the soil until it reached solid ground at the bottom. Inside that pipe a ten-inch steel pipe has been welded. The second pipe was inserted in order that the well might remain dry. At the bottom of the inner pipe has been placed a three-foot plug of waterproof concrete and two feet of sand mixed with tar. The Time Capsule, at present, rests upon this base. Last night, in preparation for this ceremony, the capsule was straightened up and a small layer of our sealing material was poured around the bottom to hold it upright in the pipe. We shall presently pour in upon the Time Capsule 500 pounds more of this material, a substance consisting of 58 per cent. petroleum pitch, 17 per cent. chlorinated diphenyl, and 25 per cent. mineral oil. This material has been specially chosen because of its resistance to electrolysis and other characteristics. Our engineers tell us that this compound alone should last for thousands of years. All the materials used have been made from coal or oil products which were in the earth for millions of years before they were put to work.

Thus, when this sealing-in is performed, the Time Capsule will be protected from the earth and elements by two thicknesses of steel pipe and an inch layer of highly resistant plastic. Even without these protections, our engineers believe that the Time Capsule would be quite capable of lasting more than 5,000 years safely. With this additional protection, its potential life will be greatly prolonged.

SCIENTIFIC EVENTS

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

THE fifth annual "Progress Report" of the Society for the Promotion of Engineering Education was released by Professor C. F. Scott, chairman of the committee, prior to the Berkeley meeting in June. The report is based on about sixty letters from officers and chairmen of the society. Items indicating progress were selected, condensed and epitomized.

The report states that increase in enrolment is significant, undergraduate students in approximately 150 engineering schools in the United States and Canada now numbering about 106,000, an increase of nearly 30 per cent. in three years. There were in 1939 4,700 candidates for the master's degree and for the doctor's degree 850, both having more than doubled in three years. The report states that this "undergraduate increase is presumably due partly to the employment situation, but mainly to the growing regard for engineering training as a preparation for careers in industry, business and public service." Mechanical engineering enrolment, which shows the greatest increase during this period, 89 per cent., "may be traced to the character of this curriculum and to the recent publicity given to aeronautics, Diesel engines and air-conditioning. Most mechanical engineering curricula stress management and labor problems, which may be an added explanation."

It is pointed out that "a notable trend in engineering education has been in the field of chemical engineering, which is maturing rapidly, and becoming more and more a mathematical, quantitative kind of

engineering; its technical literature is growing; the quality of instruction and the physical facilities of the schools are improving; and a younger generation of teachers is putting it across."

After recounting the advances being made by engineering schools in the teaching of physics, English, aeronautics, surveying, geodesy, mathematics, hydraulics and fluid mechanics attention is called to the subject of research. The report states that "prior to 1933 over half of new process and new product development came from Central Europe; in 1938, less than five per cent. Totalitarian influence on education is forcing American industry to a new dependence on research carried out in the United States."

The committee on aims and scope of engineering curricula in its contribution to the report presents the new conditions, trends and attitudes which necessitate a new study of the subject; it specifies objectives and stresses the fact that the normal basic course should prepare engineers for a wide range of technical, administrative and executive responsibilities. Some of the views it has considered include (a) the lengthening of the undergraduate curriculum to five or six years, (b) requirement of a period of preliminary study in a school of liberal arts preceding admission to the school of engineering, and (c) the trend in the direction of dividing the curriculum in the junior and senior stages.

The past year brought to completion the second stage in the accrediting program of the Committee on Engineering Schools of the Engineers' Council for Professional Development, of which the Society for the Promotion of Engineering Education is a member body. The first stage had to do with organizing the program of inspection and with developing principles and procedures. The second stage involved carrying these plans into operation. Consequently, there is available to-day an essentially complete list of accredited curricula of the engineering schools of the country for the guidance and use of state licensing boards for engineers, the national engineering societies and the thousands of high-school students contemplating an engineering career. A by-product of the investigations incident to accrediting is the interchange of information which has given opportunity for all schools, large as well as small, to improve their educational programs.

GRADUATE WORK IN CHEMISTRY AT COLUMBIA UNIVERSITY

THE adoption of a new program of studies leading to the degree of doctor of philosophy in chemistry at Columbia University has been announced by Professor Harold C. Urey, head of the department of chemistry.

Under the new system students need not enrol in a definite number of formal courses, although they are expected to register in certain classes in order to prepare for their dissertation and examinations. Hitherto candidates for the Ph.D. have followed a prescribed curriculum in much the same manner as undergraduates. Provision has also been made for greater financial assistance to those undertaking graduate work in chemistry.

The new program has been made possible through arrangements put into effect last year for exercising a greater selectivity in admitting graduate students and limiting the number matriculated for a Ph.D. degree. Students who wish to matriculate for the degree are advised that full-time rather than part-time work is desirable under the new plan. The following regulations have been made:

> In order to become candidates for the degree, students are now required to pass a matriculation examination after one full year of graduate work. Their acceptance will be based largely on the result of the examination and not upon any accumulation of undergraduate and graduate credits.
>
> Candidates will also be required to have a good reading knowledge of both French and German. Within one year after being accepted they must submit to the faculty three theses, each containing an original conclusion drawn from reading and laboratory work. These theses must be defended before an examining board comprised of faculty members in the department.
>
> The final awarding of the degree will depend upon an exhaustive dissertation prepared by the student on some original research project. The dissertation must be submitted for approval to a committee composed of members of the faculty of pure science. Although a limit has not been imposed upon the length of time necessary to carry out the research, the fact that the great majority of those accepted in the future will be students who will devote full time to their studies will automatically reduce the average time required to obtain a Ph.D. degree.

In describing the plan Dr. Urey said:

> Plans have been made to increase the amount of assistance given by the department to properly qualified students who are unable to continue graduate work without financial aid. Formerly students who were awarded teaching assistantships paying $1,000 for the academic year were required to teach twenty-four hours a week. Under the new plan this has been reduced to sixteen hours. As a result of lowering the number of teaching hours required, there has been a decided improvement in the caliber of those applying for assistantships. It was found possible to accept only a fraction of the number of excellent students who requested such aid this year.
>
> In building an outstanding graduate department it is as necessary to have a strong student body as it is to have an adequate faculty. However, despite the presence of the latter, the department can not attract competent graduate students unless a proper amount of financial support is offered by the university.

SURVEY OF THE FLORA OF GUATEMALA

A BOTANICAL expedition to survey the flora of Guatemala for the Field Museum of Natural History, Chicago, will be conducted during the next seven months by Paul C. Standley, curator of the herbarium. Mr. Standley left Chicago on September 30 to board the steamship *Zacapa* at New Orleans for Puerto Barrios. The expedition will continue explorations conducted by a similar expedition which he led in 1938–39, and an expedition conducted by Julian A. Steyermark, assistant curator of the herbarium, in the early part of 1940. The ultimate purpose of the work of all three expeditions is the preparation of a descriptive and illustrated account of the plants of Guatemala, to be published by the Field Museum Press.

The plant life of Guatemala is more varied than that of any other country of Central America, and quite possibly richer in number of species. In spite of intensive work by the previous Field Museum expeditions, there still remain important areas of the country whose flora have not yet been investigated, due to the exceedingly varied topographical features. Some regions, such as the great Department of Peten whence comes much of the chicle used in a Chicago industry, are so difficult of access that their flora is not likely to be well explored for many years. However, the government at present is extending a long road into Peten, so that during the coming winter it may be possible to reach even that region by automobile.

The present expedition is leaving early in the season in order to reach Guatemala before the summer rains and their effects have ended. The country has approximately six wet and six dry months, the latter coinciding with the autumn and winter of the north. In many parts of the country there always is sufficient moisture to support a continuous abundance of growing plants, but in other parts the vegetation during winter months is almost as greatly reduced as in the United States. It is necessary to visit these areas before too many of the plants have been killed by cold and drouth. After they have been worked as long as seems advisable, collecting will be continued in moister regions, such as the Pacific Coast and the rain forests of Alta Verapaz, the centers of coffee production.

It is expected that the present expedition will obtain species new to science, and others that have never been recorded before from Guatemala. Thus data will be provided for completing the descriptive account of the plant life of this relatively small but highly varied and exceptionally interesting country.

APPOINTMENTS AT THE MEDICAL SCHOOL OF THE UNIVERSITY OF MINNESOTA

THE following changes have been announced in the Medical School of the University of Minnesota:

Dr. J. Frank Corbett retired July 1, 1940, from the faculty as clinical professor of surgery in the Division of Neurosurgery. Dr. Corbett was made clinical professor emeritus of surgery.

Dr. Lemen J. Wells, formerly of the University of Missouri, has been appointed associate professor of anatomy.

Dr. Charlotte M. Gast has been appointed assistant professor and assistant director of the course in medical technology.

Dr. Edwin S. Fetcher, formerly of the University of Chicago, and Dr. Robert B. Dean, of the University of Rochester, have been appointed instructors in the department of physiology.

The following promotions have been announced:

Dr. Halvor O. Halvorson has been made professor of bacteriology; Dr. Raymond N. Bieter, professor of pharmacology; Dr. William A. O'Brien, professor of preventive medicine and public health and director of postgraduate medical education; Dr. Cecil J. Watson, professor of medicine and director of the Division of Internal Medicine; Dr. William T. Peyton, professor of surgery and director of the Division of Neurosurgery; Dr. George O. Burr, professor of botany and of physiology, has in addition been appointed director of the Division of Physiological Chemistry.

Dr. Arthur C. Kerkhof has been promoted to clinical associate professor of medicine; Dr. Starke Hathaway to clinical psychologist and associate professor of nervous and mental diseases; Dr. James B. Carey to clinical associate professor of medicine, and Dr. Wallace D. Armstrong to associate professor of physiology and director of biological research in dentistry.

THE MOUNT DESERT ISLAND BIOLOGICAL LABORATORY

THE Mount Desert Island Biological Laboratory officially closed its 1940 season on September 15.

At the annual meeting of the corporation held on August 8 the following trustees were elected to serve until 1943: William H. Cole, Robert W. Hegner, Warren H. Lewis, E. K. Marshall, Jr., David O. Rodick and Stanley J. G. Nowak. Trustees serving until 1942 are: Earl O. Butcher, Esther F. Byrnes, J. T. Halsey, C. C. Little, Dwight E. Minnich and Homer W. Smith. Those serving until 1941 are: Hermon C. Bumpus, Ulric Dahlgren, George B. Dorr, John Whitcomb, J. W. Burger and Roy Ph. Forster. David O. Rodick was elected clerk of the Corporation for 1941.

At the annual meeting of the trustees held on August 17, the following officers were elected for the ensuing year: Ulric Dahlgren, *president;* Dwight E. Minnich, *vice-president;* John Whitcomb, *treasurer;* and J. W. Burger, *secretary.* William H. Cole, who had served for nine years as director of the laboratory, resigned and Roy Ph. Forster was elected to replace him. Homer W. Smith and William H. Cole were elected members of the executive committee to serve with the president and director of the laboratory.

Plans for the 1941 season include the construction

of three new laboratory buildings, each designed to serve as a separate research unit.

RECENT DEATHS

DR. ALEXANDER S. BEGG, professor of anatomy and dean of the School of Medicine of Boston University, died on September 26 at the age of fifty-nine years.

DR. GEORGE RUTLEDGE, professor of mathematics at the Massachusetts Institute of Technology, died on September 21 at the age of fifty-eight years.

PROFESSOR JOHN E. EMSWILER, chairman of the department of mechanical engineering of the University of Michigan, died on September 23 at the age of sixty years.

DR. B. D. WILSON, professor of agronomy at the New York State College of Agriculture at Cornell University, an authority on the chemistry of peat and peat soils of northeastern United States, died from the results of an automobile accident on September 5. He was fifty-one years old.

EDWARD CHAUNCEY WORDEN, consulting chemist, who was head of the Worden Laboratory and Library at Millburn, N. J., died on September 22. He was sixty-five years old.

A CORRESPONDENT writes that the death of Joseph William Blankinship at Decoto, Calif., on July 2, 1938, professor of botany in Montana State College from 1898 to 1905, has only now become known. In later years, as a plant pathologist, Mr. Blankinship was employed by the smelter companies in Montana, Utah and northern California. In the course of his work he made extensive collections of spermatophytes in the upper Sacramento Valley, many of which are cited in Jepson's Flora of California.

CHARLES GABRIEL SELIGMAN, professor emeritus of ethnology at the University of London, died on September 19. He was sixty-seven years old.

PROFESSOR HANS ROSENBERG, an authority on astronomical photometry, former director of the Kiel Observatory and, of late, director of the Observatory at Constantinople, died on July 26 at the age of sixty-one years.

SCIENTIFIC NOTES AND NEWS

DR. FRANK B. JEWETT has resigned as president of the Bell Telephone Laboratories, in New York City, to become chairman of the Board of Directors. He will be succeeded as president of the laboratories by Dr. O. E. Buckley, who has been executive vice-president.

BECAUSE of difficulties in administration and especially in communication among the nations belonging to the International Astronomical Union the position of secretary has been taken over temporarily by Dr. Walter S. Adams, American vice-president of the union. Action to this effect has been approved by a majority of the members of the executive committee at the request of Sir Arthur Eddington, president of the union, and Dr. J. H. Oort, secretary. Communications relating to the activities of the union should now be addressed to Dr. Adams at the Mount Wilson Observatory, Pasadena, Calif.

A BANQUET was held in Chicago on September 14 in honor of Dr. Frederick B. Noyes, retiring dean of the College of Dentistry of the University of Illinois, in recognition of "his noteworthy contributions to the fields of orthodontia, dental education, dental research and organized dentistry." It was sponsored by the faculty of the College of Dentistry. The speakers included Dr. Allan G. Brodie, of the department of orthodontia of the College of Dentistry, who acted as toastmaster; Dr. Arthur Cutts Willard, president of the University of Illinois; Dr. Leroy M. S. Miner, dean of the Dental School of Harvard University; Dr. Arthur H. Merritt, immediate past-president of the American Dental Association, and Dr. Isaac Schour, president-elect of the International Association for Dental Research.

DR. HENRY B. ALLEN, secretary and director of the Franklin Institute, Philadelphia, and David Dietz, science editor of the Scripps-Howard Newspapers, have received the Goodrich award for distinguished public service.

PROFESSOR OLIVIER has been elected president of the Société Française de l'Histoire de la Médecine, Paris.

DR. EDWARD A. OLIVER, clinical professor of dermatology at Rush Medical College since 1927 and a member of the Rush faculty since 1912, has been appointed professor and chairman of the department of dermatology and syphilology at Northwestern University Medical School. He succeeds Dr. Arthur W. Stillians, who retired recently with the title of professor emeritus.

T. HOYLE LEE, graduate teaching assistant at the University of Wisconsin, has been appointed associate professor of mathematics at the University of South Carolina.

DR. HUGH J. BICKERSTAFF, associate director in the division of maternal and child health, Georgia State Department of Health, has resigned to become

associate professor in public health administration at the Johns Hopkins University School of Hygiene and Public Health.

DR. ROLF ELIASSEN, assistant professor of sanitary engineering at the Armour Institute of Technology, has been appointed to succeed the late Lewis Van Carpenter as head of the Sanitary Engineering Research Laboratory with the title of associate professor. Dr. Hamilton Gray, consulting engineer, has been appointed assistant professor. He will establish and direct a new laboratory for the study of foundation soils and soil mechanics. Dr. Clair N. Sawyer, doctorate fellow in sanitary engineering at the University of Wisconsin, has become assistant professor of sanitary engineering.

DR. C. R. CARPENTER has been appointed associate professor of psychology at the Pennsylvania State College. He will continue to cooperate with the School of Tropical Medicine at San Juan, Puerto Rico, in work with the Santiago Primate Colonies, holding a nominal appointment as research associate.

DR. ELFRIEDE FREDERICK BROWN, of the Colorado State College, has been made associate professor of foods and nutrition at the Iowa State College.

DR. WALTER B. LANCASTER, ophthalmic surgeon, associate in ophthalmology at the Harvard Medical School, has been appointed chief of staff of the Eye Institute of Dartmouth College. He will take up the work on November 1.

DR. VERNE VINCENT CALDWELL, professor of psychology at the Oregon College of Education, has been appointed dean of the General Extension Division of the Oregon State System of Higher Education.

PROFESSOR M. M. RHOADES has been elected managing editor of *Genetics* in succession to Professor L. C. Dunn. Manuscripts intended for publication in *Genetics* should be sent to Editor of *Genetics*, Schermerhorn Hall, Columbia University.

DR. JOHN M. BUTLER, who recently received his doctorate in organic chemistry from the Ohio State University, has become a member of the Bakelite Corporation, Unit of Union Carbide and Carbon Corporation at Bloomfield, New Jersey.

JACK COMPTON, formerly connected with the Cellulose Laboratory of the Boyce Thompson Institute for Plant Research at Yonkers, N. Y., has become a member of the Physical Research Laboratory of the B. F. Goodrich Company, Akron, Ohio.

PHILIP C. COOKE has been appointed director of engineering and maintenance of Sharp and Dohme, Philadelphia. Dr. Willard F. Verwey has joined the staff of the Medical Research Division.

DR. FRANCIS S. SMYTH, professor of pediatrics at the Medical School of the University of California, has returned from a leave of absence which he spent in South America, part of the time in the laboratories of Professor B. A. Houssaye, of the Physiological Institute of Buenos Aires.

THE Middleton Goldsmith Lecture of the New York Pathological Society will be given at the New York Academy of Medicine on October 4 by Dr. William Cramer, of the Barnard Free Skin and Cancer Hospital, St. Louis. His subject will be "Sex Hormones and the Endocrine Balance."

TWELVE Thursday night lectures on "Cultivation of Trees and Shrubs" will be given at 7:45 at the New York Botanical Garden, Bronx Park, by P. J. van Melle, nurseryman and the horticultural writer of Poughkeepsie. This series inaugurates the autumn term of a two-year course designed for amateur gardeners. A second series, on "Cultivation of Greenhouse Plants," will begin in January and the spring term will bring a course in "Indoor Gardening Practice." A science course for professional gardeners will open, with registration at 7 P.M., on October 7.

THE autumn convention of the Electrochemical Society will be held in Ottawa, Canada, from October 2 to 5.

THE annual meeting of the Research Council on Problems of Alcohol will be held in New York City on October 15. There will be seven group conferences at 11 A.M. and a luncheon at 1 P.M.

A CONFERENCE on Nuclear Physics will be held on the occasion of the opening of the new physical laboratory of Indiana University on Friday and Saturday, October 25 and 26. Speakers at the conference and their subjects are as follows: Professor I. I. Rabi, Columbia University, "The Possibility of Measuring Spins and Magnetic Moments of Radioactive Nuclei"; Professor G. Breit, University of Wisconsin, "Formal Aspects of Resonance Theories on Nuclear Reactions"; Professor L. A. DuBridge, University of Rochester, "Some Nuclear Reactions Produced by High Energy Protons"; Professor H. A. Bethe, Cornell University, "Present Status of the Theories of Nuclear Forces"; Professor Don M. Yost, California Institute of Technology, "Studies on Vitamin B Using Radioactive Tracers"; Dr. Joseph G. Hamilton, University of California, "Tracer Studies on Biology and Medicine."

THE Production Division of the American Management Association will meet on November 12 and 13 in Cleveland to discuss manufacturing problems created by the industrial preparedness program. The sessions will be held at the Hotel Cleveland. To deter-

mine specifically the problems created for the average concern by the increased industrial tempo, the American Management Association for weeks has been in touch, through letter and questionnaire, with companies representing virtually every industry in the United States. The association reports that it finds hundreds of companies engaged in the solution of individual manufacturing problems, nearly all confronted with major problems involving personnel, methods and materials.

DR. ANTON J. CARLSON has given his library of scientific journals and monographs to the department of physiology of the University of Chicago. He became professor emeritus on October 1, having reached the age of sixty-five years. The library includes approximately sixteen thousand classified reprints of scientific articles, twelve hundred books and research monographs and complete files of fifteen scientific journals.

H. H. HSIAO, head of the department of psychology of the National Central University at Chungking, China, writes to SCIENCE under date of August 20 as follows: "Owing to the governmental control of foreign exchange, we have been out of touch with new literature in the field of psychology almost since our removal to Szechwan, but there is an increasing need for up-to-date information in our research work here. We wish that you will render us the much-needed help by sending your donations in the form of reprints, periodicals or test forms."

AT a recent special meeting of the membership the official name of the National Association of Audubon Societies was changed to the National Audubon Society. The organization, whose purpose is the protection of wild bird and animal life, was founded in 1905.

THE *Journal* of the American Medical Association reports that the biochemical division of the Bureau of Animal Industry of the U. S. Department of Agriculture has been merged with the pathologic division and the division of animal nutrition. The position of chief of the biochemical division has not been filled since the death of Robert M. Chapin. Activities of the division relating to animal diseases have been transferred to the pathologic division and those relating to the nutritive value of animal products have been assigned to the animal nutrition division at Beltsville, Md.

DR. C. STUART GAGER writes: "At a visit to the Bowdoin College Library this past summer, I was interested to find there an extensive work of some twenty volumes of illustrations in water color of the flora of Maine, by the late Kate Furbish. The sheets are somewhat larger than a standard size herbarium sheet, and are beautifully bound. They date from April, 1870, to October, 1908, and include, besides flowering plants, illustrations of about five hundred Maine mushrooms dating from May, 1897, to October, 1905. Since this is a manuscript work it occurs to me that its existence may not be generally known to systematic botanists, and others who might be interested in the flora of Maine. No public notice is known of this work, except in one of the local papers at the time the gift was made to the library, and in the annual report of the president of Bowdoin College for 1908–1909. The librarian writes me that 'Personally, I should be very glad to have the attention of botanists called to this work for strictly scientific purposes, or even for their own interest. The college should be glad to cooperate with any real botanist in the use of this work.'"

WE are requested by the Stanford University Press to state that when Volume I of Abrams's "Illustrated Flora of the Pacific States" was published in 1923 the paper stock was unsatisfactory, with the result that the pages are now rather brittle and will not stand the long handling that a reference book of this type is subjected to. As a result the edition has been reprinted on a much better quality of paper rather than distribute more of the original printing. Volume I is now printed on paper that will last indefinitely. Some necessary corrections have been made and the price of the volume has been reduced from $9.00 to $7.50. Copies of the first printing returned to the press will be credited with $3.00 on the purchase price of the new edition. Volume II of this series, describing and illustrating 1,655 species in families from Buckwheats to Kramerias will be published in December. There will be four volumes in all, rather than three as originally intended.

As reported in *Nature*, Dr. Raymond Priestley, vice-chancellor of the University of Birmingham, in the course of a circular letter addressed to headmasters of a number of schools in the Midlands, has pointed out that the age at which undergraduates will be called up for military service has been fixed by the Government at twenty years. This will enable many men to complete their university training before entering the Services. With the object of enhancing the value of such men to the national effort, it has been decided by the University of Birmingham that all future entrants will be required to choose one of the following options as part of their university course: (1) compulsory physical education for one year; or (2) two years service in the University contingent of the Officers Training Corps. Those who choose the latter will be accepted for the Officers Training Corps only if they are approved by an interviewing board set up by the Military Education Committee, the main criteria being personality and power of leadership (latent or developed). Training in the O.T.C. will be carried out with the view of

developing powers of leadership rather than training technical experts. The advantages of this general military training apply equally to those taking medical and dental courses, since the military background essential to an R.A.M.C. officer can be adequately acquired in this way. Those who obtain War Certificates A and B will have definite advantages when they are called up for military service.

DISCUSSION

THE ACTIVE REGION ON THE SUN'S SURFACE

IN the *Publications of the Astronomical Society of the Pacific* Volume 47, August, 1935, it was shown that for two periods of 80 solar rotations each there was a permanent region of high solar activity as shown by Wolfer's sun-spot relative numbers.

The first series of 80 solar rotations began on January 6, 1917, and ended on December 25, 1922, and the second series began on May 16, 1925, and ended on May 4, 1931. Both series gave the maximum sun-spot activity on the same day of the average rotation period of 27.25 days. The periods were separated by 872 days (32 rotation periods) in order to include the sun-spot maxima of 1917 and of 1927–28.

The Character Figures of Solar Phenomena, as given in volumes I and II of *Publications of the International Astronomical Union,* were tested in the same manner as were the sun-spots for both 80-rotation periods, and while the results were not as definite as in the case of the sun-spots, owing to the number of missing days, they were sufficiently definite to show without question that the region of maximum sun-spot activity applied to the calcium flocculi and to both the bright and dark hydrogen flocculi which accompanied the sun-spots.

Since *The Monthly Weather Review* has been publishing daily records of the area of visible sun-spots expressed in millionths of the sun's visible surface, and since we have been passing through another period of maximum sun-spot activity, it has seemed worth while to determine if the region of maximum solar activity still persists and if it may be identified by means of the areas covered by sun-spots as it was by Wolfer's sun-spot numbers.

To test this question the total areas of visible sun-spots for each day of twenty solar rotations of 27.25 days each, beginning on July 1, 1938, and ending on January 6, 1940, were arranged in successive periods and the average total sun-spot area for each day of a single solar rotation was determined. The result is indicated by Fig. 1, where the ordinates represent 1/20 of the average spot areas for each day of one solar rotation period and the abscissas represent the days of the rotation.

The maximum sun-spot area occurred on the 14th day of the average rotation period. The date of the

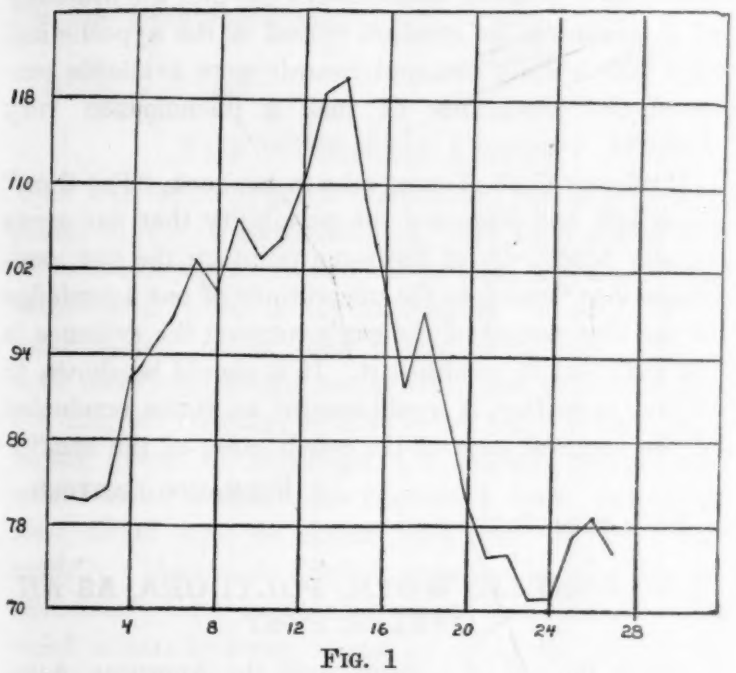

FIG. 1

last maximum of the two sun-spot series referred to above occurred on May 2, 1931. From May 2, 1931, to July 14, 1940, there were 3,287 days, equaling 121 solar rotations of 27.25 days each, thus establishing the fact that the active region on the sun's disc has persisted for 23 years since January 6, 1917.

This period is certainly too long for the persistence of a single sun-spot, and during this time there have been several years without any conspicuous sun-spot.

There are also indications that it has persisted for a much longer period. For example, the great sun-spot reported by Howlett in *Monthly Notices of the Astronomical Society of London,* 1865–66; crossed the central meridian of the sun on October 13, 1865. It had an area of more than 972 million square miles. The greatest sun-spot mentioned by Maunder, which he says was the greatest for twenty years and perhaps the greatest ever recorded at Greenwich, crossed the central meridian of the sun on October 31, 1903.

Between the passage of these two great spots there were 38 years and 18 days, 13,897 days. Allowing 27.25 days to one solar rotation would give exactly 510 solar rotations between the passage of these two great spots.

From the great Howlett spot of October 13, 1865, to July 14, 1940, was 27,109 days. Assuming that there were 995 solar rotations in this period, a single rotation would require 27.245 days, lacking only 7 minutes of 27.25 days, which period has been selected as the

solar rotation period of the northern sun-spot belt on the sun.

Evidently the active region on the sun's surface has persisted for more than seventy-five years.

It has been suspected for many years that there was a persistent region of high solar activity, but the apparent impossibility of the existence of such a region on a globe of incandescent gas and the difficulty of determining the rotation period of the hypothetical spot before daily sun-spot records were available rendered the acceptance of such a phenomenon very doubtful.

Professor C. A. Young, who in his book, "The Sun," page 148, has discussed the possibility that sun-spots appear repeatedly at the same point on the sun, concludes that "owing to the uncertainty of our knowledge of the true period of the sun's rotation the evidence is not sufficient to establish it. If it should be shown to be true hereafter, it would compel an entire revolution of the received view of the constitution of the sun."

FERNANDO SANFORD

PALO ALTO, CALIF.

THE ANNELID WORM, POLYDORA, AS AN OYSTER PEST

WITH the aid of a grant from the American Association for the Advancement of Science through the South Carolina Academy of Science, a study is being made of one of the numerous pests to which the commercial oyster, *Ostrea virginica,* of the Atlantic Seaboard, is subject and whose activities result in considerable financial loss to oystermen.

This particular pest is a small annelid which causes a "mud blister" in the oyster. This is a small, irregular, often pear-shaped, blister of mud, formed on the surface of the inside of the valve. The oyster covers this daub of mud with a layer of nacre. Within the blister one finds the annelid, which has access to the outside through two tunnels opening along the edge of the shell. This worm has been identified by Dr. Olga Hartman as *Polydora ciliata* (Johnston). Although *Polydora* is well known, its occurrence in such abundance as to become an oyster pest seems as yet unreported in the United States.

The worm upsets the normal life of the oyster by restricting its living space and generally weakening it. Infested oysters, although not unfit for food, are not readily salable because of their unsightly appearance.

I have had these worms and the blister they cause under observation since 1935. Indications are that the worms were prevalent in South Carolina even in precolonial days. An examination of numerous samples of South Carolina oysters shows that approximately 30 per cent. of the oysters in the state are infested with *Polydora.* The important point of the present investigation is to discover the possible underlying causes of its prevalence and its possible increasing abundance, and to determine means for its control.

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ALFRED B. NOBEL AWARDS IN SCIENCE

THE Alfred B. Nobel Prizes in five activities have been awarded since 1901. The 1939 winners were recently announced. Comparative ratings of the different countries whose citizens have received these distinctions have been made at various times, but such comparisons usually have not taken into account the relative populations of the various countries. Such comparisons are manifestly unfair since they give too low a placement to those countries of small population and too high to those of large populations.

In order to present a fairer estimate of the different countries' attainments in the sciences—chemistry, medicine and physics—they are here figured on a population basis, and where the prize was awarded to more than one person, each has been counted as a unit rather than as a fraction. Since the awarding committee could make no distinction between the winners, it seems unfair to the laureates and to their respective countries to count them otherwise than as separate winners. Counted in this manner there have been 128 laureates in the sciences listed under 16 different countries. The only Hungarian winner (in medicine and physiology in 1937) has been included with Austria since they were in that country previous to the Versailles Treaty. India and Russia have not been placed in the tables since the former has had but one prize winner and the latter only two. India would be rated last in Tables I and III; Russia next to last in Table I and last in Table II (she has had no prize winner since 1908). Dr. Charles D. Snyder in an article entitled "The Real Winners in the 1936 Olympic Games"[1] set forth the results in the Olympic Games in this manner.

The ideal quota is obtained by finding the sums of

TABLE I

CLASSIFICATION OF NOBEL WINNERS IN THE SCIENCES (1901–39) FOR COUNTRIES BASED ON POPULATION

Country	Number of winners	Ideal quota	Per cent. attainment	Comparative rank	Date of last award
Switzerland	5	1.2	417	1	1939
Denmark	4	1	400	2	1926
Holland	9	2.6	346	3	1938
Sweden	6	2	300	4	1929
Germany	37	20	185	5	1939
Great Britain ..	21	12	175	6	1937
Austria	6	5	120	7	1937
France	15	13	115	8	1935
Canada	2	3	67	9	1923
Belgium	1	2.6	40	10	1919
United States ..	15	40	38	11	1939
Italy	3	13	23	12	1938
Spain	1	8	13	13	1906

[1] *Scientific Monthly,* 372, Oct., 1936.

TABLE II

COMPARATIVE RATING FOR FIRST 29 YEARS

Country	Number of winners	Ideal quota	Per cent. attainment	Rank
Denmark	4	0.83	500	1
Sweden	6	1.4	423	2
Holland	7	1.8	400	3
Switzerland	3	1	300	4
Germany	27	15	180	5
Great Britain ...	14	8.4	167	6
France	13	9.3	140	7
Canada	2	2.3	87	8
Austria	3	3.7	81	9
Belgium	1	1.8	55	10
Italy	2	9.3	21	11
United States ...	5	27	18	12–13
Spain	1	5.4	18	12–13

the postwar populations of the countries in each table and dividing this sum by the total number of prize winners for that period. This gives the population corresponding to one prize winner. The post-war population of each country divided by the prize winning population gives the ideal quota for the respective countries.

The results calculated in this manner are tabulated in Tables I, II and III.

TABLE III

COMPARATIVE RATING FOR LAST 10 YEARS

Country	Number of winners	Ideal quota	Per cent. attainment	Rank
Switzerland	2	0.43	465	1
Holland	2	0.92	217	2
Great Britain ..	7	4.0	175	3
Austria	3	1.8	162	4
Germany	10	7.4	135	5
United States ..	10	13	78	6
France	2	4.5	44	7
Italy	1	4.6	22	8

The true leaders in the sciences now appear since the smaller countries are no longer handicapped by their small populations. Four of the smaller countries lead in Tables I and II. Great Britain and Germany have had very uniform records. In the last ten years the United States has shown a distinct improvement. Her performance is four times as high as it was in the first twenty-nine years.

HARVEY C. BRILL

MIAMI UNIVERSITY

THE WITCH OF ANDOR

IN a letter to SCIENCE (Lancaster, Pa. and/or Garrison, N. Y.) of September 13, 1940, it is stated that "The use of the form 'and/or' in legal practice is well established." So is the expression "to-wit," if we mean widely rather than wisely established; but, if both these expressions can be restricted to legal usage, the English language will be better off. With a little better grasp of language, the original perpetrator would have avoided the fractional form (which as read aloud may be either "and over or" or "and-orths"). Accepted English practice is to place an alternative term in parenthesis, as "and (or)." The chief abuse, however, is not in using the expression awkwardly and inaccurately but in using it at all. We have far too much of such writing as "You may have sugar and/or cream in your tea and/or coffee, and/or pepper and/or salt on your meat and/or potatoes." When really necessary, the idea is best conveyed by saying "or either" or "or both."

E. H. MCCLELLAND

CARNEGIE LIBRARY OF PITTSBURGH

SCIENTIFIC BOOKS

THE GEOLOGY OF CHINA

The Geology of China. By J. S. LEE. xv + 528 pp., 93 figs. London: Thomas Murby and Company. New York: Nordemann Publishing Company. 1940. $9.00.

THIS book grew out of lectures by the author in British universities during 1934–35 under the auspices of the Universities China Committee in London. It contains much valuable material, especially for those who want a rapid oversight of China's geology before studying intensively from sources of detailed information. For the geologist, the book is too brief, too inconclusive, too speculative. For the layman, it is far too full of technicalities, many of which are not needed to convey the meaning clearly. The book could be used in China as a text for students who have had their general physical and historical geology.

By far the most serviceable portion is the tenth chapter; a summary of the stratigraphy of China by regions, defining the formations and listing their chief fossils. All who are interested in the geology of Asia will welcome this chapter, which extends through 100 pages.

A lack which every geologist will immediately feel upon reading the book is the absence of a brief chapter on the history of geology in China. Strangely enough, the author gives a history of China as a nation, plausibly defending his course by claiming to show "the influence upon human geography of the natural regions which have been defined." But his history is political and cultural, and his interpretation of history—to say the least—is his own.

Lacking an account of the development of geology in China, the book gives no picture of the work of such men as Pumpelly, Richthofen, Obruchev, Loczy, Willis, Blackwelder, Fuller, Clapp, Andersson, Ting, Grabau, Wong, Berkey, Black, Teilhard—to give only a partial list. These men are casually referred to for local details; the reader must learn from other sources

what large and constructive parts they played in the development of geological science in China, in the organization of publications devoted to the science and in arousing interest in the study.

Indeed, the author seems to suppress, as far as possible, credit to foreign workers—a common tendency in contemporary Chinese writing. It springs, no doubt, from the new nationalistic spirit, and we who see its counterpart in certain European nations should not be severe about it. The habit of scrupulously giving credit for work done is accepted in America as a matter of course; and we believe that China would gain, not lose, by giving full credit to the able and devoted men who have kindled the light of science for her.

The mineral resources of China are scarcely touched upon. Copper is mentioned thrice, each time in less than a sentence. Iron, gold, tungsten, antimony, are all dismissed in eight lines on one page. Petroleum fares better, being mentioned on four pages, on one of which it enjoys a paragraph. Coal is mentioned on many pages, chiefly as a member of a stratigraphic series, rather than as a resource. Kaolin, fire-clay, alunite, are barely mentioned. Especially in a pioneer book on the geology of China, a good analytical chapter on economic mineral resources would be welcome.

The book contains 93 illustrations, of which 26 represent fossils. Of these, 14 are full-page plates crowded with pictures of index fossils. No one could use these plates to identify fossils; they serve neither the geologist, the student nor the layman, except that the last would like to see a picture of the Peking Man. I think it would have been better to refer the reader to Grabau's volumes on index fossils of China—surely the briefest *serviceable* treatment of this vast subject—and to devote these plates to maps, structural cross-sections and topographic drawings such as Fenneman and Atwood have used so successfully in describing the United States.

Seven more figures are devoted to artifacts, none of which is needed in a book on geology, especially as four of them represent early Chinese pottery. Twenty-two figures are photographic views, but of these 17 are devoted to the problem of glaciation, leaving only five pictures for all the rest of China. The book contains 22 maps, of which the first represents the geomorphologic provinces, superposed upon the political provinces. Names of both sets of provinces, plus the names of mountain-ranges, rivers and lakes, are of course necessary; but to these are added many cities and all the railroads—the latter drawn in bolder lines than are any of the features for which the map was made. Twenty-one illustrations are devoted to structure—some to generalized structures such as folds made by pushing wet paper on a smooth surface according to Tsuboi's method (to whom no reference is made); some to reconstructions of geosynclinal troughs; while others are cross-sections recorded in the field.

The book is of value, even as it stands; and the author deserves praise for a gallant assault upon a most difficult task. The reviewer has known the author for more than twenty years and bears a warm personal friendship for him; and considers that he shows his friendship best in frankly pointing to some of the many defects in the book. The reviewer sincerely believes that the book should be thoroughly revised and reillustrated; that much of the speculative discussion in Chapters VII and VIII should be omitted and separately published as papers representing the author's views.

There are ten chapters, each with a selected bibliography. The first chapter describes the national provinces of China. Most of the 19 provinces as defined by the author are true geomorphologic units, based upon structure. To the reviewer this "physiographical" chapter seems the right place to tell of peneplanes, terraces, cycles of erosion, drainage-history; but these are postponed to inadequate, and partly erroneous, treatment in Chapter IV, pages 194–207.

Among the misconceptions in the present chapter only one will be cited:

The Manchurian Plain is "an homologous feature of the North China Plain" (page 12). But the former is a warped inland basin, or group of basins, whose floor is beveled across rocks of many ages and structures. The Manchurian basin is more nearly homologous with its western neighbor, the Gobi basin, than with the North China Plain, which is a confluent delta-plain made of Pleistocene and recent silts. Manchuria's true homologue for the North China Plain is the Liao delta, not the warped basins. Again, on page 14, we read, "After being submerged in the Gulf of Pechihli the Plain of Manchuria is continued further south-west by . . . the Plain of North China." This would be true if the Manchurian Plain were warped down under the Gulf and arched up again in the south-west.

Chapter II describes the ancient rock-floor of China, divided into three systems; the Archaean, the Wutai, separated by the Lulianian Revolution from the overlying Sinian system. The discussion of the last-named system is one of the best features of the book; but much confusion clouds the description of the earlier systems.

In Chapters III and IV the author is on firmer ground as he writes of "marine transgressions and epochs of tectonic movement"—extending from Cambrian through Triassic history; and "Post-Palaeozoic formations and the Yenshan movements," wherein he writes of continental deposits whose ages range from Triassic to Recent.

Chapter V is devoted to "Cathaysian geosynclines and geanticlines"—the troughs trending northeast-southwest in eastern China. The author discusses a Palaeocathaysian geosyncline, which received the Sinian deposits of late pre-Cambrian time, and was renewed after disturbances until the close of the Permian. The author recognizes "the obscure history of the Mesocathaysian geosyncline," in which he includes late Permian and Triassic marine sediments in South China, "the northern counterpart" of which came "down from the Arctic, past the maritime province of Siberia, and probably joined the Triassic trough in northern Korea." The Neocathaysian geosyncline is taken to include the marginal mediterranean Sea of Japan, the Yellow Sea and the Tunghai. This last is not named on any map in the book; and is not so called in most atlases. It should mean the East China Sea; but the confusion is increased by the author's statement (page 259) that the eastern Tsinling Range "sinks under the Yellow Sea or Tunghai"—whereas elsewhere he distinguishes between these two confluent seas.

He describes an "inner Neocathaysian geosyncline . . . an extensive trough running obliquely across China from northern Manchuria to the central Yangtze province. . . . In the North China Plain the sediments in the geosyncline probably amount to many thousands of feet in thickness." He adds to this bold statement, "Apart from the superficial cover, nothing is known about them at present." The only evidence cited for their great thickness is that borings at Tientsin showed fresh-water deposits 500 feet below sea-level. This fact is offered as evidence of subsidence; but the author disregards the lower sea-levels of the Pleistocene and the fact that delta sediments sink by compaction as the delta grows. The depth of these fresh-water deposits is too moderate to prove geosynclinal sinking.

Chapter VI treats of "east-west tectonic zones" of folded structure. One of these is in the Tannu and Kentai mountains. "The middle part of this zone is obviously disturbed by the Khangai Mountains which more or less follow the 'Irkutsk Amphitheatre' in trend, and which are undoubtedly related to the latter. Because of this powerful disturbance thrusting in from the north, the east-west zone could not have maintained its rectilinear front" (pages 247–248). Apparently the author thinks the Tannu and Kentai ranges were continuous, and that the Khangai is overthrust upon them from the north. No trace of such a structure is known in the field, nor are the rocks of the Tannu and Kentai identical. The inference appears to rest on the author's interpretation of "trends."

Farther south, "the Inshan zone" is made to include the many small short ranges just north of the great bend of the Yellow River. The author extrapolates these folds far to the eastward to account for the node in Hokkaido, where the Tertiary ranges of the Kurile arc and the Sakhalin folds "join and give rise to a great display of vulcanicity" (page 250). This entire thesis is speculative, to say the least. The only physical evidences which the author cites are certain east-west folds in Manchurian coal-basins and a coincidence in the approximate latitude of the node in Hokkaido with that of the Inshan zone. Similar reasoning is done throughout the chapter.

Reference has been made to the still more speculative chapters VII and VIII, respectively on "Shear Forms" and "Tectonic Types and Their Related Earth Movement."

Chapter IX is a review of the evidence bearing on "Pleistocene Climate in China." The author reviews the scattered observations and concludes that in the Lower Yangtze Valley, three successive glaciations took place, separated by interglacial epochs.

Chapter X, on "Regional Stratigraphy," is referred to in the first part of this review as the best and most serviceable chapter in the book. It is a pleasure to close a review that necessarily includes some criticism with a word of well-earned praise.

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SPECIAL ARTICLES

SEROLOGICAL SPECIFICITY OF HEAVY PARTICLES DERIVED FROM NORMAL ORGANS

THE nature of certain particles separable from normal tissue extracts by relatively high centrifugal forces is under investigation in a number of laboratories.[1] In the course of studies of the virus of human influenza in this laboratory, it was found that particles of similar chemical composition could be separated from the lungs of normal, healthy mice and from the lungs of mice in the final stages of influenzal pneumonia. It has been suggested that such "high-speed sedimentable" cell components may correspond with histologically recognizable mitochondria,[2] and further,

[1] A. Claude, SCIENCE, 91: 77, 1940; K. G. Stern and F. Duran-Reynals, SCIENCE, 89: 609, 1939; C. R. Amies and J. G. Carr, *Jour. Path. and Bact.*, 49: 497, 1939; J. Furth and E. A. Kabat, SCIENCE, 91: 483, 1940; D. G. Sharp, A. R. Taylor, H. Finkelstein and J. W. Beard, *Proc. Soc. Exp. Biol. and Med.*, 42: 459, 1939.

[2] A. Claude, *op. cit.*

that they may be related with the pathogenic agent in certain virus diseases.

The question of the possible relation between these normal particles and the various infectious processes necessarily has led to an investigation of their serological specificity.

Healthy Swiss mice were dissected after death by ether, and the several organs were collected in jars submerged in an alcohol-dry ice bath. After storage at −7° to −10° C., the organs were ground with sand to form 10 to 20 per cent. suspensions in saline. After low-speed centrifugation the suspension was passed through a medium Mandler filter. This was followed by repeated alternate centrifugation at 25,000 RPM for 20 minutes and at 1,500 RPM for 5 minutes. The materials used for inoculation were washed three times, those for agglutination, only twice. Suspensions of particles from the following organs were prepared: liver, lung, kidney, spleen, pancreas, testicle, muscle and brain.

The material sedimentable from Mandler filtrates in each case formed a translucent, yellowish to reddish-brown pellet of gelatinous consistency, which could be resuspended only by very vigorous manipulation with a rubber-tipped plunger. Dark-field examination showed the particles to be of fairly uniform size about 0.1 μ to 0.3 μ in diameter, as might have been expected from consideration of the filter pore size and the centrifuge constants. The small bodies did not stain typically with the usual nuclear or acidophilic dyes, but were blackened by osmic acid and absorbed Janus Green B strongly, a fact which may support Claude's suggestion of a mitochondrial origin. Analyses of the sediments are not yet complete, but they appear to conform with the data of Claude,[3] *i.e.*, they contain nucleoprotein, a large proportion of ether extractable material and a high total ash.

When injected into mice intravenously, the suspended particles produced rapid death characterized by coagulation of the blood in the venous system and emptying of the left heart and arteries. In one instance (brain) the toxicity could be eliminated by suspension of the particles in antisera against any one of the organ particles, but usually not in normal serum. Preparations, other than from brain, have not yet been studied in this respect.

Antisera against each of the washed organ sediments were prepared by 7 intravenous injections into rabbits of 2 cc volumes at two- or three-day intervals. Nine days after the last injection, the animals were bled and the serum recovered. Normal serum from the same rabbits was kept in the frozen state for reference.

The following properties of the antisera have been found:

(1) Precipitins for mouse serum were usually entirely absent. In a few instances a slight precipitate was detected after preliminary incubation at 37° C. and overnight refrigeration and centrifugation, and only one of the antisera showed a slight ring formation with mouse serum diluted 1:100 on standing for 20 minutes.

(2) In half of the sera, there was an increase in mouse red cell agglutinins over that observed in the serum from the same animals before injection. In only three instances did the increase appear to be significant (10 to 20 times).

(3) Sheep cell hemolysins were present in all the antisera, with titers up to 1:5,000 with a 5 per cent. cell suspension. This observation is a confirmation and extension of that of Furth and Kabat[4] with respect to the presence of Forssman antigen in preparations from normal spleen of the chicken.

(4) A positive Kahn test was obtained with most of the antisera, but also with the normal sera.

Of the eight different types of antiserum, four (anti-brain, liver, kidney and testicle) showed reactions definitely specific for the homologous antigen. In slide agglutinations, the antigens were specifically agglutinated, *i.e.*, the reactions first became apparent (sometimes within one minute) in the homologous antiserum, although cross-reactions appeared later with some of the other antisera. The homologous reaction was usually stronger than the ultimate cross-reactions. Brain particle suspensions were agglutinated *only* by the homologous antiserum. Muscle, spleen, lung and pancreas particles have given indefinite or negative results thus far, although it is possible that the antisera in these cases were inadequate. Further investigation of this possibility is in progress. Table I summarizes the relationships encountered in our experiments.

TABLE I

HOMOLOGOUS AND HETEROLOGOUS AGGLUTINATION (SLIDE) OBTAINED WITH PARTICLES FROM VARIOUS MOUSE ORGANS

Particulate antigen	Rabbit serum *vs.* mouse organ particles from: Brain	Kidney	Liver	Lung	Muscle	Pancreas	Spleen	Testicle	Saline	Normal sera
Brain	2	0	0	0	0	0	0	0	0	0
Kidney	0	4	3	1	2	0	0	0	0	0
Liver	0	1	3	1	1	0	0	0	0	0
Lung	0	1	1	1	1	0	0	0	0	0
Muscle	0	1	3	0	3	0	0	0	0	0
Pancreas ...	1	1	1	1	1	1	1	1	1	x
Spleen	0	2	2	2	1	2	2	2	0	0
Testicle	0	1	1	1	1	0	0	2	0	0

4 = all particles in a few large masses.
0 = no reaction.
1 to 3 = various degrees of agglutination.

Since cross-reactions appeared in a number of the cases, confirmation of the apparent specificity was

[3] *Ibid.*

[4] J. Furth and E. A. Kabat, *op. cit.*

sought through absorption experiments. Definite proof of specific antibodies in sera against kidney, liver, testicle and possibly muscle particles was obtained, as shown in Table II.

TABLE II

EFFECT OF ABSORPTION ON SPECIFICITY OF SLIDE AGGLUTINATION

Antigen	Serum absorbed with	Rabbit serum *vs.* mouse organ particles from: Lung	Kidney	Muscle	Liver	Testicle	Saline
Kidney particles	.....	1	4	1	2	0	0
	Kidney	0	0	0	0		
	Muscle	0	4	0	0		
	Liver	0	4	0	0		
	Sheep red cells	1	4	1	2		
Liver particles	.....	1	1	2	4	0	0
	Kidney	0	0	0	3		
	Muscle	0	0	0	4		
	Liver	0	0	0	0		
	Sheep cells	1	1	2	4		
Muscle particles	.....	1	1	3	3	0	0
	Kidney	0	0	±	0		
	Muscle	0	0	0	0		
	Liver	0	0	2*	0		
	Sheep cells	..	..	..	..		
Testicle particles	.....	1	1	1	2	2	0
	Liver	0	0	0	0	2	

* Apparently some specificity in this experiment, but not observed in other muscle preparations.

It is obvious from these experiments that the antibodies can be absorbed completely only by the homologous antigen, while cross-reactions apparently disappear upon absorption with any one of the heterologous antigens. The Forssman antibodies are not concerned with these cross-reactions, since no change occurs upon complete absorption with sheep cells. There was no definite relation between the mouse serum precipitins or mouse red cell agglutinins and these cross-reactions.

Using particles derived from another species—the ferret—we have observed agglutination of liver only, by mouse liver antiserum, and of brain only by mouse brain antiserum, while kidney particles were not agglutinated by any one of the sera. Ferret muscle antigen cross-reacted with several antisera, other than anti-muscle.

These experiments prove that particles derived from some normal mouse organs by high-speed centrifugation (25,000 RPM) show, in addition to the Forssman antigen, organ specific differentiation. The question of organ specific structures in tissues and cells has been studied repeatedly (*cf.* Landsteiner[5]). While in certain instances (*e.g.*, lens, brain and others) organ specificity is demonstrable without great difficulty, in other cases (kidney, liver) the results have been more or less indefinite.

[5] K. Landsteiner, "The Specificity of Serological Reactions," C C Thomas, Springfield, Ill., 1936.

As a result of these various studies, different types of organ-specific antigens have been identified.[6] One group is characterized by the fact that the same antigen is present in the homologous organ of many different species. Our results show that liver as well as brain particles conform with this type.

The kidney particle preparations employed in our experiments belong to another group of organ specific antigens which are found in one organ from one species only. However, since we have used only two species, it is obvious that these observations must be extended.

In a number of instances, it has been possible to ascribe organ specific reactions to alcohol extractable material.[7] The particles used in this study contained high percentages of lipoids, but the relation of these fractions to the specificity is still under investigation.

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STABILIZATION OF IODINE IN SALT AND FEEDSTUFFS

ON the Industrial Fellowship on iodine at Mellon Institute we have had occasion to investigate broadly the factors responsible for the loss of iodine from iodized salt and iodized mineral feeds. These mixtures may contain any or all of the following substances: ferric oxide, copper sulfate, cobaltous nitrate, sodium chloride, manganese sulfate, calcium carbonate, calcium phosphate, sodium sulfate, sulfur, potassium iodide, volatile flavors, organic meals and vitamin concentrates. Potassium iodide is furnished to the feed manufacturer in the form of either an iodized mineral mixture, a concentrated iodized pre-mix containing the essential minerals or an iodized salt. The primary cause of loss of iodine is through oxidation of the iodide to free iodine with subsequent volatilization. Another important factor is the absorption of potassium iodide by the fabric or cardboard containers. The formation of free iodine not only results in a loss of iodine but also causes a decrease in the vitamin C content of the feed.

Iodized mineral feed mixtures lose between 9 per cent. and 20 per cent. of their iodine content during four months' storage under ordinary conditions. Oxidation occurs mainly through the catalytic action of iron, copper and manganese compounds present in the mixtures. These reactions take place only in the presence of moisture and are accelerated by the action of light. An important synergism is observable in this catalytic action. Ferric oxide becomes appreciably

[6] E. Witebsky, Report of Proceedings, 2nd Intern. Congress of Microbiol., London, 1937.
[7] E. Witebsky, *Zeitschr. f. Immunitätsf.*, 62: 3, 1929.
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soluble in the presence of soluble manganous compounds, and the catalytic activity of iron and copper together is much greater than the additive effects of iron and copper separately.

The loss of iodine from iodized salt depends upon the oxidizing impurities in the salt, chiefly chlorate, nitrate and ferric chloride. Iodized salt for animal feeding, which contains large amounts of potassium iodide, loses iodine with great rapidity. Iodized salt for human consumption, which contains 0.02 per cent. potassium iodide, loses 40 per cent. or more of the iodine in eighteen months. If the salt is freshly prepared, approximately 15 to 20 per cent. of the iodine is lost during the first month.

Stabilization by the use of alkaline agents and reducing agents has been recommended and extensively used. But this treatment has not been entirely successful because of the inability to obtain adequate contact between the reacting components in a dry powder. The employment of a reducing agent in conjunction with a soluble pyrophosphate is more effective. Pyrophosphate forms an inactive complex with oxidized iron; it also destroys the synergism between iron and copper.

A new and simplified procedure for stabilizing the iodine reinforcement of comestibles has come from our work. The process consists of milling 100-mesh alkali iodide with a small portion of a non-toxic metallic soap. The milling of 92 parts of potassium iodide with 8 or more parts of calcium stearate in the form of an impalpable powder is recommended; the powder density of the calcium stearate should be as low as possible. The resulting product is a stable free-flowing powder, coated with calcium stearate and practically insoluble in water. The coating is rapidly emulsified in the presence of bile. Calcium stearate is non-toxic and may be ingested in reasonable amounts with complete physiological safety. Various grades of the impalpable powder are available commercially.

A mineralized salt, containing 10 per cent. ferric oxide, 2 per cent. copper sulfate, and 4 per cent. potassium iodide coated with calcium stearate, has lost only 0.9 per cent. of its iodine content during storage for four months, while the same formula without calcium stearate has lost 15 per cent. of the iodine. An iodized livestock mineral containing 0.21 per cent. stearate-coated potassium iodide lost 0.5 per cent. of the original iodine content during two months, while an unstabilized mineral containing the same ingredients lost 14 per cent. of its iodine content. Absorption of the stearate-coated potassium iodide by cardboard, paper or fabric containers does not occur.

Calcium stearate also functions to prevent caking in table salt. As iodized table salt contains 0.02 per cent. potassium iodide, it is necessary to employ 0.2 per cent., or ten times as much calcium stearate as potassium iodide, to be effective in preventing caking. The cost is comparable to that of present methods.

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A NEW FACTOR OF THE VITAMIN B COMPLEX REQUIRED BY THE ALBINO MOUSE

IN view of the wide use of the albino mouse as an experimental animal, particularly in medical research, it is surprising that so little is known about its dietary requirements. The work that has been done[1,2,3,4,5] indicates that the nutrition of the mouse differs markedly from that of the rat. It was stated by Birch, György and Harris[6] that mice on the Goldberger black-tongue diet supplemented with 5 International Units of thiamin and 15γ of riboflavin injected twice a week failed to grow and developed skin lesions and loss of hair, whereas rats on the same diet grew normally.

In the study of the requirements of the albino mouse for the several factors of the vitamin B complex, a basal diet consisting of purified casein, 18 per cent., sucrose, 75 per cent., cod liver oil, 1 per cent., butter fat, 2 per cent., and Osborne and Mendel's salt mixture, 4 per cent., is being used, supplemented with known factors of the B complex.

When crystalline pyridoxin, thiamin, nicotinic acid and riboflavin are injected at various levels up to 10γ, 25γ, 25γ and 15γ respectively per day, failure of growth results in every case, and a characteristic skin lesion develops in from 30 to 40 days. If the crystalline supplements are fed with the basal diet at levels of 100γ of pyridoxin, 250γ of thiamin and nicotinic acid and 150γ of riboflavin daily, the same results are observed as when the B factors are injected.

The addition of liver or yeast, or the water or dilute (30 per cent.) alcohol extract of liver or yeast to the diet produces normal growth and maintains healthy skins in mice. However, feeding the basal diet supplemented with pyridoxin, thiamin, nicotinic acid and riboflavin with the addition of the filtrate from a fuller's earth adsorption of either yeast or liver extract neither produces growth nor prevents the appearance of skin lesions in mice when feeding amounts of filtrate equivalent to 0.1 gram and 0.2 gram of yeast daily or 0.5 gram of liver every other day. In only one case[7] have skin lesions been described on a diet adequate in thiamin, pyridoxin, nicotinic acid, ribo-

[1] H. H. Beard, *Am. Jour. Physiol.*, 76: 206, 1926.
[2] H. H. Beard, *Am. Jour. Physiol.*, 75: 668, 1925.
[3] F. C. Bing and L. B. Mendel, *Jour. Nutrition*, 2: 49, 1929.
[4] E. Pomerene and H. H. Beard, *Am. Jour. Physiol.*, 92: 282, 1930.
[5] J. M. Wolfe and H. P. Salter, *Jour. Nutrition*, 4: 185, 1931.
[6] T. W. Birch, P. György and L. J. Harris, *Biochem. Jour.*, 29: 2830, 1935.
[7] P. György and R. Eckhardt, *Nature*, 144: 512, 1939.

flavin and the "filtrate" or "rat growth" factor fed to rats. The symptoms described are similar to those reported here, but differ in certain essentials.

The skin lesions observed in the mouse differ in several respects from conditions of dermatitis described in the literature.[8] The paws, ears, nose and tail, and in most cases the eyes appear normal. In a few cases a sticky exudate is observed about the eyes. The lesions are preceded by loss of hair on the abdomen, closely followed by the appearance of shiny dry skin in the inguinal region. This in turn is soon followed by a scaly dandruff-like appearance beginning almost simultaneously on the back of the neck and in the inguinal region. If the animal survives this stage of the deficiency, the pelt frequently begins to come off in large plaques, particularly on the back, leaving a dry but otherwise normal-appearing hairless skin. In some cases it has been possible to keep the animals alive until they became completely denuded except for a slight amount of fuzzy hair around the head. In some cases, the peeling off of the pelt does not occur, but instead the dandruff-like appearance spreads over the body and the hair gradually falls out, leaving the animals covered with dry white scales. Early in the course of the deficiency the animals usually assume a hunched position with the hind feet drawn far up underneath the body. Histopathological examination of all organs and sections of the skin is now being made. At autopsy, the animals are found to be emaciated, but otherwise normal in gross appearance.

Mice require a water-soluble factor other than thiamin, nicotinic acid, pyridoxin, riboflavin and the "filtrate factor."[9] The required factor is present in yeast and liver. A study of the properties of this substance is now in progress.

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[8] N. Halliday and H. M. Evans, *Jour. Nutrition*, 13: 657, 1937.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SUBSTITUTE FOR EDESTIN

EDESTIN, the globulin of hemp-seed, has been regarded as a standard example of the seed globulins for many years. Osborne[1] subjected this protein to more detailed and extensive study than any other globulin, and his demonstration with Mendel[2] of its adequacy as the sole source of protein in the diet of animals has led to extensive use of edestin in certain types of animal experimentation. It serves, for example, as a convenient protein relatively free from phosphorus.

In recent years, many amino-acid determinations[3] have been made upon edestin, with the result that the composition of this protein is better known than is that of any globulin in its molecular weight class; in the cases of only a few other proteins are higher summations of amino-acids available. Furthermore, much attention has been given to its physical properties,[4] and the preparation of a sample of this protein has long been a standard exercise in laboratory courses in biochemistry.

The passage of the Marihuana Law of 1937 has placed restrictions upon trade in hemp-seed that, in effect, amount to prohibition. The seed may be purchased only under license, and transfer is subject to a tax of one dollar an ounce (if illegal, one hundred dollars an ounce). On application to the Collector of Internal Revenue, properly accredited persons may obtain exemption from this tax, and provisions are made in the law so that scientific research on marihuana (the legal definition of which includes all parts of the plant, and all products, save fiber, oil and seed cake prepared from it and from its seed) shall not be impeded.

Hemp-seed is produced only in small quantities in the United States, chiefly in Kentucky, and the plant may be grown only under license. Most of the hemp-seed is imported from the Orient, and there are only a few importers in the country who are licensed by the Federal Narcotics Division to engage in this trade. The seed is devitalized by heat treatment on receipt by the importers and may then be sold without restriction. It is used chiefly in various special feeds such as bird-seed.

The general effect of these restrictions is to render the purchase of hemp-seed for the preparation of edestin a time-consuming and troublesome process. The devitalized seed is useless, since the yield of protein is reduced to less than one twentieth of that from untreated seed. Although some laboratories may be willing to face the difficulties involved, the licensed

[1] T. B. Osborne, *Am. Chem. Jour.*, 14: 662, 1892; *Jour. Am. Chem. Soc.*, 21: 486, 1899; 24: 28, 39, 1902; T. B. Osborne and I. F. Harris, *Jour. Am. Chem. Soc.*, 25: 837, 1903; *Am. Jour. Physiol.*, 14: 151, 1905; T. B. Osborne and L. M. Liddle, *Am. Jour. Physiol.*, 26: 295, 1910.

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[4] E. J. Cohn, *Physiol. Rev.*, 5: 349, 1925; N. F. Burk and D. M. Greenberg, *Jour. Biol. Chem.*, 87: 197, 1930; C. F. Failey, *Jour. Am. Chem. Soc.*, 54: 2367, 1932; R. W. G. Wyckoff and R. B. Corey, SCIENCE, 81: 365, 1935; E. J. Cohn, *Chem. Rev.*, 24: 203, 1939.

importers are not enthusiastic about cooperation, since they think in terms of tons and they are also fully alive to the penalties that are risked if unauthorized persons secure some of the seed.

It seems clear that the long and important career of the protein edestin is coming to a close in the United States. A substitute must be found, and it is the purpose of this communication to draw attention to the problem this presents. The substitute for edestin must be a seed globulin of approximately the same solubility; it should be a protein that is easily prepared in crystalline and therefore presumably pure form; it should be derived from a seed that is an important crop not only in America but elsewhere, and it is desirable that it should be relatively cheap. A survey of possibilities in this field has led, largely by elimination on one ground or another, to the plants of the family Cucurbitaceae. Many species are commonly grown, and considerable study has been given to the proteins. Squash-seed globulin was prepared by Osborne[5] in 1892 and has been occasionally investigated since. Cantaloupe seed has been studied by Jones and Gersdorff.[6] Hirohata[7] has examined the globulins of some thirty-eight varieties and species of eight genera of this family and has drawn attention to the close similarity, if not identity, of the globulins from closely allied species. Kiesel and his collaborators[8] and also Krishnan and Krishnaswamy[9] have studied the globulin of watermelon seed.

Considerations of availability have led us to the tentative suggestion that the globulin of the pumpkin seed (*Cucurbita pepo*)[10] may be found to fulfil most of the requirements of a substitute for hemp-seed edestin. Numerous varieties are grown, and the seed is a waste product of the canning industry in some states. It is always available on the market at a price that is usually a small fraction of that commanded by most cucurbit seeds.

A series of proteins from commonly available cucurbit seeds is under investigation in this laboratory. Although there are minor differences in the behavior of the different seeds, all yield well-crystallized globulins when the ground, whole seed is extracted by means of a hydraulic press with warm 10 per cent. sodium chloride solution. After removal of the emulsion of fat which readily rises from the warm solution, the filtered aqueous phase is diluted to about 2 per cent. sodium chloride concentration at 60° C. This clear solution is slowly cooled to about 5° C., when the protein deposits almost entirely in the form of octahedral crystals. Reprecipitation under similar circumstances gives, as a rule, a very fine product. The yield is of the order of 10 per cent., somewhat higher than that usually secured from hemp-seed.

A report on the preparation and nutritive properties of one or more of these globulins and on certain of their chemical properties will form the subject of a later communication.

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[8] A. Kiesel, A. Belozersky, P. Agatow, N. Biwschich and M. Pawlowa, *Ztschr. f. physiol. Chem.*, 226: 73, 1934.

[9] P. S. Krishnan and T. K. Krishnaswamy, *Biochem. Jour.*, 33: 1284, 1939.

[10] *Cucurbita pepo* includes the common field, pie and cattle pumpkin of North America and also the vegetable marrow. There are several varieties recognized in systematic works, and many varieties are commonly grown. *C. moschata* is a closely allied species that includes the cushaw and crookneck squashes and other varieties known both as pumpkins and as squashes. *C. maxima*, also closely allied, includes such well-known squash varieties as Hubbard and Boston Marrow as well as certain very large varieties commonly called pumpkins. Whether varietal or even specific differences in these plants are reflected in the main storage globulins of the seeds is unknown. Uncertainty on this point presents no graver problem, however, in this case than is presented by any other protein of vegetable or for that matter of animal origin.

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